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A COMPLICATED STEEL DOME.

Before the California earthquake and fire of 1906 the Emporium building at San Francisco was surmounted by a large dome of structural steel resting on the steel framework of the main building. During the conflagration this dome was so damaged as to make its reconstruction impossible, but the main steelwork of the building was left in such condition that it could be used in rebuilding. The reconstruction of the building, therefore, included the repair of the main frame and design and construction of a new dome, the architectural features of which are such as to make the steel framing most intricate. Through the courtesy of Messrs. Levering & Garrigues,* who held the contract for the fabrication and erection of the framework, we are enabled here to present a view and drawing of the steel construction.

The general dimensions of the dome are as follows: Diameter, 102 ft. 6 ins.; height of dome proper, 51 ft. 9 ins.; height to top of lantern, 67 ft.; diameter of lantern, 22 ft. 6 ins.

The main frame consists of eight heavy lattice girder ribs resting at their base upon a circular girder of the main building and framing at the top into a circular lattice girder, which in turn supports the lantern. Two intermediate horizontal circular lattice girders are framed into the main ribs of the dome and serve to brace the same and carry the intermediate rafters which start at the level of the top of the large arched openings, of which there is one between each pair of ribs. The main frame of these arched openings, which are 25.9 ft. in diameter, is composed of a 15 in. I-beam resting at the bottom upon the circular girder previously mentioned, and connected at the top to the lower of the intermediate horizontal circular girders bracing the ribs. The total weight is about 200 tons.

The covering is of heavy glass held in place between the horizontal and vertical ribs of the dome by 2 × ⅜-in. bars.

As there is hardly a straight piece of steel in the whole framing the contractors, whose works are at Dunellen, N. J., decided not to risk the sending of the pieces all the way to San Francisco without first testing the fit in their own shop. Fig. 1 is a view of the entire steel dome set up on temporary concrete piers at Dunellen, the field connections being made with bolts. It was found that the workmanship was so exact that no readjustment was required and the dome was dismantled and shipped to San Francisco, where it has since been erected.

*532 West 23d St., New York City.

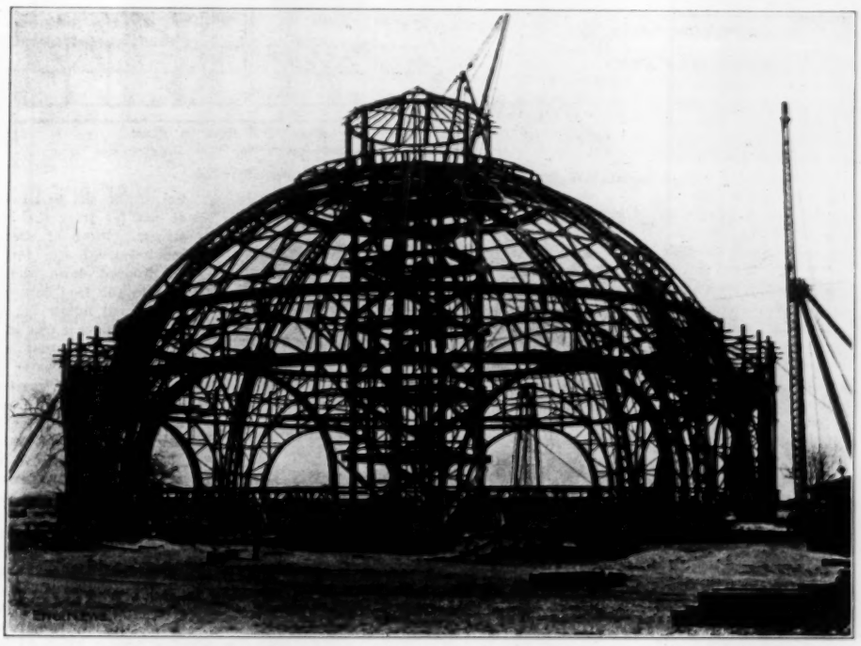


FIG. 1. DOME FOR EMPORIUM BUILDING, SAN FRANCISCO, SET UP IN YARDS OF LEVERING & GARRIGUES, DUNELLEN, N. J.

SOME OF THE ENGINEERING PROBLEMS INVOLVED IN THE CONSTRUCTION OF A DEEP WATERWAY FROM THE GREAT LAKES TO THE GULF OF MEXICO.*

By J. A. OCKERSON, M. Am. Soc. C. E.†

The remarkable revival of interest in the development of waterways, and particularly the deep-water project from Lake Michigan to the Gulf of Mexico, by way of the Illinois and Mississippi rivers, opens up questions of vast importance not only to the people of the Mississippi Valley, but to the whole country.

LAKE MICHIGAN TO THE MISSISSIPPI RIVER.

A project for a waterway from Lake Michigan to the Mississippi River by the way of the Illinois River dates back to the earliest settlement of the country.

The State of Illinois, with the aid of land grants voted by Congress, constructed the Illinois & Michigan Canal, which was opened to traffic in 1848. It begins 6 miles from the lake in the Chicago River and terminates at the head of navigation on the Illinois River at Lasalle, a distance of about 97 miles. Below Lasalle the Illinois River has been improved by locks and dams, both the state and the United States having contributed to this work. The project for improving the river provided for a navigable channel 7 ft. deep, the locks being 75 ft. wide by 350 ft. long.

When the Chicago Drainage Canal was authorized by the State of Illinois, the project for a 7-ft. waterway was practically abandoned and the state declared itself in favor of a waterway not less than 14 ft. in depth, to be constructed by the United States from Lockport to Lasalle, the locks to be constructed in such manner as to permit of future development to a greater capacity if required.

In 1902 Congress provided for a Board of Engineers to determine the feasibility of constructing a 14-ft. waterway from Lockport to Grafton on the Mississippi River, and called on the Mississippi River Commission to furnish like information for the Mississippi River from Grafton to St. Louis. Plans and estimate of costs were required by the act.

In 1905 the reports were completed. The plan of the Board of Engineers proposes to canalize the river from Lockport to Utica, a distance of 63.5 miles, the fall being 136 ft. Nine locks and five movable dams are proposed, the upper lock having a lift of about 40 ft. The lock dimensions prescribed are 80 ft. wide and 600 ft. long, with a depth of 14 ft. over the miter sill. The upper end of the channel would connect with the Chicago drainage canal at Lockport.

The Sanitary District has already constructed a navigable canal with a depth of 22 ft. and a length of 36 miles.

The Board of Engineers were only required to consider the question of navigation; hence the development of water power in connection therewith was not discussed. If the utilization of the water power that could be developed in connection with the improvement becomes a part of the project, then a different arrangement of the locks proposed will be desirable.

From Utica to Grafton, a distance of 229.5 miles, the work proposed is to dredge a channel 200 ft. wide at the bottom, with a depth of not less than 14 ft. at low water. This involves the excavation of 27,867,000 cu. yds. of earth and 40,989 cu. yds. of rock. The estimated cost of the projected improvement from Lockport to Grafton is $23,543,582. The estimated cost of the reach from Lockport to Utica averages $241,822 per mile; from Utica to Grafton, $35,676 per mile.

The low-water slope from Utica to Grafton is about 0.14 ft. per mile, or a total fall of only 33 ft. in 229 miles. The low-water discharge of the river at Utica is about 500 cu. ft. per sec., and this amount would be wholly inadequate for a channel of the dimensions named. The constant volume of 10,000 cu. ft. per sec. drawn from Lake Michigan through the drainage canal will, however, provide ample flow for purposes of navigation, and will also permit the development of a large amount of power above Utica. The total power that can be developed is estimated at about 135,000 HP., assuming a flow of 10,000 cu. ft. per sec. from Lake Michigan.

*Condensed from a paper read before the Engineers' Club of St. Louis, Feb. 5, 1908.

†Member Mississippi River Commission, 1301 Ligget Building, St. Louis, Mo.

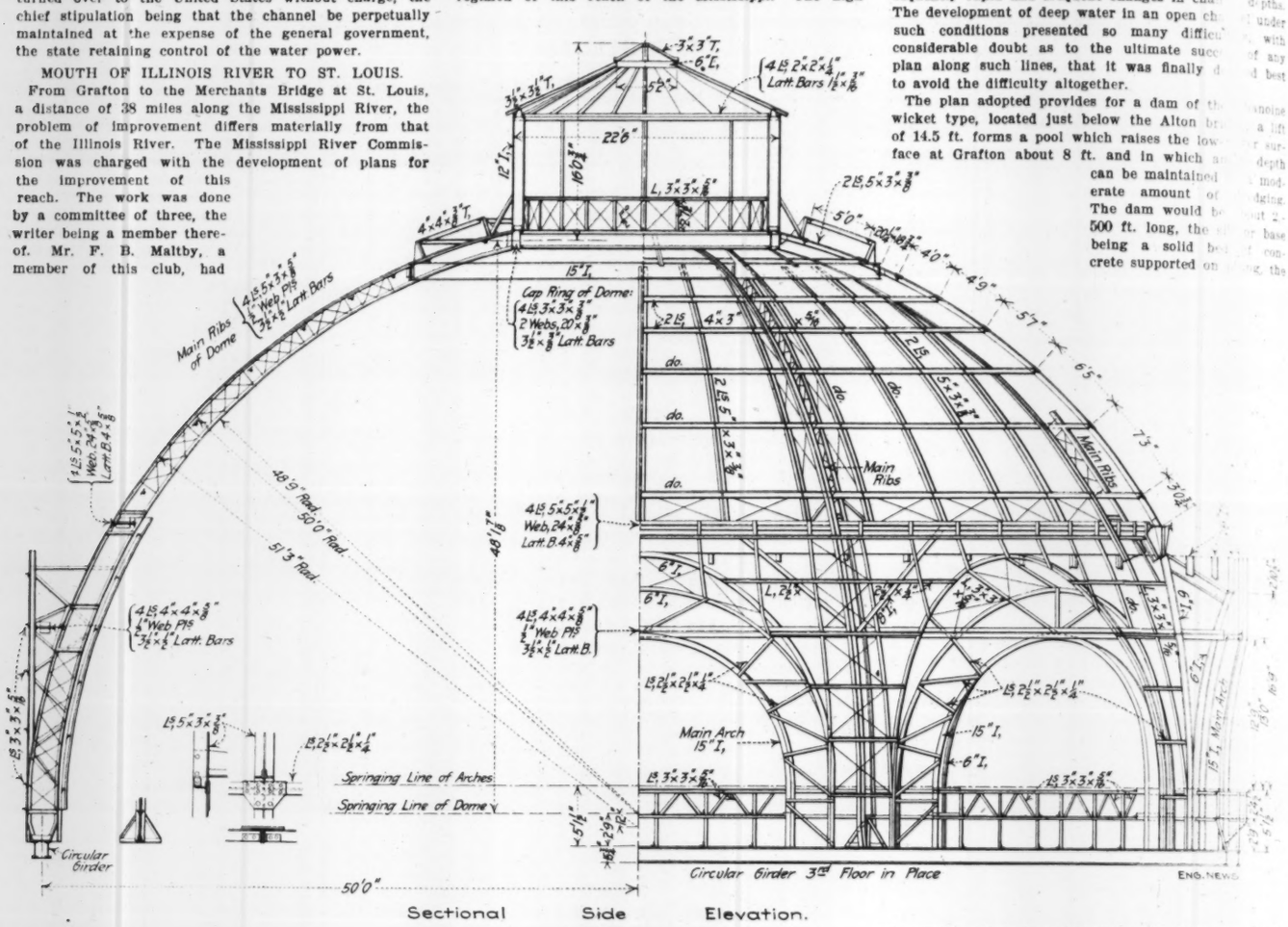
The State of Illinois proposes to undertake the whole improvement, including the water-power feature. When completed, the navigable channel will probably be turned over to the United States without charge, the chief stipulation being that the channel be perpetually maintained at the expense of the general government, the state retaining control of the water power.

MOUTH OF ILLINOIS RIVER TO ST. LOUIS.

From Grafton to the Merchants Bridge at St. Louis, a distance of 38 miles along the Mississippi River, the problem of improvement differs materially from that of the Illinois River. The Mississippi River Commission was charged with the development of plans for the improvement of this reach. The work was done by a committee of three, the writer being a member thereof. Mr. F. B. Maltby, a member of this club, had charge of the field investigations and development of details under the direction of the committee.

The Missouri River is a disturbing element in the regimen of this reach of the Mississippi. The high-water or low-water conditions in the two rarely co-incident, and hence there are frequ in slope, acceleration or decrease in velocity sequently rapid and frequent changes in cha The development of deep water in an open ch such conditions presented so many difficu considerable doubt as to the ultimate succ plan along such lines, that it was finally d to avoid the difficulty altogether.

The plan adopted provides for a dam of th wicket type, located just below the Alton br of 14.5 ft. forms a pool which raises the low face at Grafton about 8 ft. and in which a can be maintained erate amount of The dam would b 500 ft. long, the being a solid be crete supported on



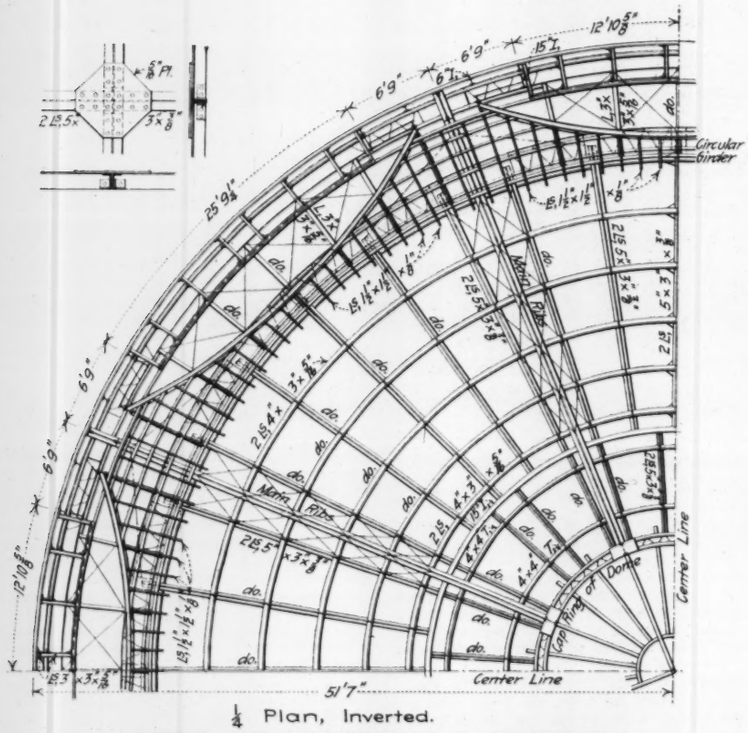


FIG. 2. STEEL FRAMEWORK FOR LARGE DOME.
(Fabricated by Levering & Garrigues, New York City.)

top of the sill to be 3.5 ft. below the low-water mark, or not far from the surface of the natural bed of the stream. Rows of sheet piling are provided to prevent scour beneath the dam. At high stages this dam will be dropped down and will present but slight obstruction to the free flow of water, and at such times navigation will follow the open river.

From the east end of the dam to the Merchants Bridge at St. Louis a canal is planned to follow along near the river, and the water surface level of the pool above the dam will be carried down to the lower end of the canal, where a lock with a lift of 30 ft., 80 ft. wide and 600 ft. long permits of the passage of vessels from the canal level to the deep water of St. Louis Harbor. That is to say, with the dam in operation during the low-water period, there will be slack water navigation 14 ft. in depth from the mouth of the Illinois River to the Merchants Bridge, a distance of about 38 miles.

At the upper end of the canal, guide piers of concrete are provided to make the entrance easy. A pair of guard gates is also planned to regulate the influx of water at flood stages. The gates, walls and embankments are to be built to a height well above the highest known floods. The canal itself is 18 miles in length. The bottom width is 160 ft., with side slopes of 1 on 2, a berm being left 5 ft. below the water surface to support a covering of riprap some 10 ft. in height to protect the banks from wave wash.

The canal is wholly in excavation, and the earth therefrom will form an impregnable levee along its entire length, and when constructed will effectually eliminate all danger from floods in that vicinity, provided similar protection is carried from its lower end down stream. Thus a large proportion of the expense involved in the thorough protection of the American Bottoms from floods is provided for in this project.

The estimated cost of the work from the mouth of the Illinois River to St. Louis is $6,553,880, or about $172,470 per mile. This is a good round sum, but unusual difficulties are involved, and little or no doubt exists as to the complete success of the project proposed. After all, the estimated cost per mile is materially less than the cost of bank revetment alone on the lower river. Taken as a whole, the project of a 14-ft. water-

way f[illegible] Lockport to St. Louis can be successfully carried [illegible]s planned, or if commerce demands it, even greater [illegible]ths can readily be secured.

ST. LOUIS TO CAIRO.

From [illegible]Louis southward the deep-water problem is in the ha[illegible] of a board of engineers who are actively engaged [illegible]g investigations necessary to a clear understanding [illegible]all questions relating to the means of developing [illegible]suitable channel 14 ft. in depth.

The [illegible] from St. Louis to Cairo, a distance of 180 miles, [illegible]nts greater difficulties in the development of a d[illegible]aterway than any portion of the route from the La[illegible] to the Gulf, and the best course to pursue has not yet [illegible]n fully determined. One serious feature is the ex[illegible]e slope, which averages about 0.6 ft. per mile at [illegible] water, and another is the influx of sediment from th[illegible]issouri River.

It is, of course, desirable to have an open channel, free from all obstructing locks if practicable, as under such conditions the capacity of the waterway is practically unlimited. It might be that this could be attained by holding the water back by submerged dams or other regulation works, supplemented by dredging.

The total slope at low water is about 100 ft., and any method of deepening the channel involves the diminution or elimination of the slope in reaches of suitable length dependent upon local conditions. Locks and dams at suitable intervals would accomplish this result, but there is no precedent for their use in a stream so heavily charged with sediment, which might have a tendency to fill up the pools in a very short time. Whether a combination of flushing and dredging can be devised to meet this difficulty is a question worthy of serious consideration, and it is quite probable that a satisfactory solution can be reached.

A canal parallel to the river could be constructed without any serious difficulty. Its capacity would, of course, depend on its size, and this must be determined by a compromise between cost and the demands which would probably be put upon it by traffic. While the movement of vessels in a canal would necessarily be slower than in an open channel, it would be free from the present difficulties encountered in upstream navigation.

It seems probable that a combination of the three types of construction suggested, applied to different sections of this reach, will prove to be the most economical and efficient solution. With the volume of water available at the lowest stages, augmented as it will be by the addition of 10,000 cu. ft. per sec. or more from the Great Lakes, there is little or no room to question the feasibility of developing and maintaining, by adequate means, a navigable channel not less than 14 ft. in depth. Whatever the project adopted may be, it will necessarily involve more or less bank protection and dredging.

The project under which improvement work has been carried on in this reach provides for the development and maintenance of an 8-ft. channel at all stages except when the river is closed by ice. The construction work embraces bank revetment, contraction of channel by means of dikes and low-water dredging. All of this work has been successfully prosecuted for a number of years, so far as the appropriations would permit. A thorough examination made during the low-water season of 1907 showed a navigable channel 8 ft. in depth.

CAIRO TO THE GULF OF MEXICO.

From Cairo southward the problem of deep-water development changes again. Here the river enters the great alluvial basin and flood control becomes an essential feature of any plan of improvement.

The low-water flow which at Utica is 500 cu. ft. per sec. omitting the lake contribution, and at St. Louis 40,000, becomes at Cairo over 70,000 cu. ft. per sec. at low-water, and 1,600,000 cu. ft. per sec. at high water. The low-water slope from Cairo to Red River averages 0.35 ft. per mile, or about one-half the average slope from St. Louis to Cairo.

Under natural conditions, without improvement, a navigable depth of 14 ft. is available for six months or more each year, even in exceptional low-water years. The obstructing bars which would require deepening to 14 ft. lie between Cairo and the mouth of the Red River, a distance of 765 miles. The 300 miles of river below the mouth of Red River has ample depth at all seasons of the year, even for ocean vessels.

The improvement below Cairo is under the control of the Mississippi River Commission. Under the present project the work consists of the construction of levees for the control of floods, the maintenance of a channel "not less than 9 ft. in depth at all stages except when closed by ice," and the revetment of banks for the purpose of preventing cut-offs through narrow necks of land, the protection of important levees and the water fronts of cities.

FLOOD CONTROL.

The levees now reach a length of about 1,450 miles. The several states have had the largest share in the cost of their construction. The character of work required is fixed by the plans and specifications prescribed by the Mississippi River Commission.

The levee system is by no means complete, either in height or section, yet it affords a good measure of protection. This is shown by the fact that the flood of 1907, which has only been exceeded six times in the past 40 years, and reached within 1.8 ft. of the highest recorded flood, was carried down for 975 miles without a single break in the levees. The development of the Alluvial Valley due to such protection has been little short of phenomenal. In a brief space of time the tangled wilderness has given place to fertile fields, and many thriving towns and villages have sprung up.

DREDGING FOR A NINE-FOOT CHANNEL.

The dredging work required to maintain a 9-ft. channel is almost entirely confined to the first 250 miles below Cairo. There are only about 40 bars or crossings in the entire reach from Cairo to Red River, which may develop shoals with less than 9 ft. thereon. They have never been known to be shallow at the same time, and it very rarely occurs that even one-half of them become obstructions to navigation in any single low-water season. The largest number of bars dredged in a season down to date is 17. During the last three years only five bars have required dredging each year, and but few of the bars show lack of depth at the same time. A crossing with deficient depth one year may have ample depth for several years in succession. As a general rule, shallow bars are looked for in a few well-defined localities each season. A very large percentage of the 765 miles shows depths of 9 ft. or more at all stages, leaving a comparatively small amount with deficient depth which must be increased by artificial means. Furthermore, the duration of the low-water period, when the depth may be deficient, does not exceed five months in the year as a maximum, and is more often covered by a period of three months.

Under the project cited, little difficulty has been experienced during the past six years in maintaining a 9-ft. channel by means of dredging. The Mississippi River Commission has nine available dredges, but only five of these have been needed during the low-water seasons of the past five years. The work required to maintain a channel varies greatly with different seasons but it does not depend wholly on the variations of stage. The vertical oscillations of the bed of the river itself conform in a great measure to the changes in stage. A channel 10 ft. deep at a 10-ft. stage may still have 6 ft. or more in depth after a fall of 8 ft., or there may be even a less depth at a higher stage.

It will be seen, therefore, that the problem of maintaining a deep channel in a silt-bearing stream is somewhat complicated, in that it is impracticable to determine beforehand how much work will be required in any low-water season.

EXPERIMENTAL DREDGING FOR A DEEP WATERWAY.

The Mississippi River Commission has had three dredges at different crossings during the past low-water season, testing the practicability of developing and maintaining depths of 14 ft. or more by means of dredging. So far as the experiments have gone, the indications are decidedly favorable. Channels of such depth have been developed and maintained without difficulty.

The dredging for channels 14 ft. in depth was done at Linda, 82 miles below Cairo; Island 35, 192 miles below Cairo; and Corona, 204 miles below Cairo, and the following results were obtained:

Linda was dredged three times following changes in stage, and a 16-ft. channel was developed and maintained.

Island 35 crossing was dredged four times, giving a channel depth of 17 ft.

At Corona the dredge cuts were from 7 to 12 ft. in depth and channel depths of 16 ft. were secured.

It is proper to say, however, that the low-water conditions during the season were not such as to require a great amount of dredging, as the river was somewhat above the normal summer stage.

NORMAL CHANNEL CONDITIONS.

There is not a foot of the entire length of the river from Cairo to the Gulf of Mexico which has not depths of 14 ft. or more at all stages in some portion of the cross-section. That is to say, the pools overlap one another and are separated by the obstructing bars or crossing.

Just what depth may be found on any crossing at low water can only be determined by actual soundings at low-water stage. It must be apparent, owing to the shifting character of the river bed, that soundings taken at higher stages and reduced to low water would be greatly misleading and of no value in deducing low-water depths.

Surveys were made during the low-water season from Cairo to Corona, 203 miles, in 1902; from Corona to Arkansas River, 198 miles, in 1904; from Arkansas River to Vicksburg, 198 miles, in 1894; and from Vicksburg to Red River, 165 miles, in 1895. A careful examination of the results of these surveys, covering 765 miles of the river, shows that there were 9 crossings in the first-named reach, with depths less than 14 ft.; 6 crossings in the second reach; 10 crossings in the third reach; and 4 crossings in the fourth reach; or a total of 28 crossings, with an aggregate length of 43,200 ft., or a little over 8 miles and about one per cent. of the total distance. Had the surveys of the two first-named reaches been made during the extreme low-water seasons of 1894 and 1895 when the other two reaches were surveyed, there is little doubt that a greater number of deficient crossings would have been found.

An investigation made in connection with dredging during the lowest water of the season of 1904 showed 33 crossings with depths less than 14 ft. between Cairo and mouth of Arkansas River. This number would be excessive, if anything, as no special effort was made to follow the line of deepest water.

The lowest stages so far recorded occurred during the years 1894 and 1895 and the low-stage conditions were prolonged. The 14 crossings, showing less than 14 ft. in depth between the mouth of the Arkansas River and Red River, may, therefore, be regarded as representing extreme low-stage conditions. It may be said further that only four crossings between Vicksburg and the Gulf of Mexico, a distance of 470 miles, showed depths less than 20 ft.

In view of the foregoing facts, it does not seem probable that the total number of crossings or bars below Cairo with channel depths less than 14 ft. will ever exceed 45 in number in any one year. Assuming an average length of a mile each, which is undoubtedly excessive, the aggregate length would be about 4.2 per cent. of the total distance. So the elimination of these bars by means of regulation works and dredging cannot be regarded as an exceptionally formidable task.

There has been a good deal of speculation as to the effect of dredging through a bar in lowering the pool above. If this actually occurred to an appreciable extent in a succession of bars and pools, it might become serious. The most careful measurements, however, fail to disclose any such results.

Little or no enlargement of the cross-section of the stream occurs, as the overlapping portions of the pool sections are largely eliminated by connecting them with a dredged channel.

BANK EROSION AND ITS PREVENTION.

By far the greatest source of supply which contributes to the development of sand bars in the lower Mississippi River is the erosion or caving of the banks. The volume of solid material per annum from this source amounts to an average of 9½ acres 66 ft. deep for each mile of river between Cairo and Donaldsonville, a distance of 885 miles, or over a million cu. yds. for each mile of river, a quantity quite sufficient to account for all of the sand bars; and it is hardly fair to charge the Missouri River with furnishing all or even a very large percentage of the material that contributes to the obstructions to navigation between the mouth of the Ohio and the Gulf.

In the reach below Cairo the development of a deep channel will necessarily include the fixing of the badly caving banks, and this will doubtless prove to be the largest item of expense. The work of the Mississippi River Commission, extending through a number of years of experimental work, has developed a type of revetment which is found to be equal to the task of holding caving banks even in the most difficult bends of the river.

The problem presented is by no means an easy one. The banks often extend 40 ft. or more above low water, while the thalweg of the river bed lies 60 ft. below the same. Thus we have a saturated bank about 100 ft. high resting on a base of silt which is readily moved by the rapid current. Comparatively slight obstructions to the current cause whirls and eddies which are destructive in their effect, sometimes undermining the revetment, unless it is carried well out into the stream.

Experience developed the necessity of wide mattresses, 300 ft. in width in some cases, instead of 100 ft. as used in the earlier work. It also proved that spur dikes at intervals of 450 ft. cannot be relied upon to hold the banks without continuous revetment between. To be effective the interval must be so small that their use is no longer regarded as advantageous or economical.

The standard revetment as now used consists of a mattress of willows heavily weighted with stone, covering the bank from near the low-water line down. The upper bank is graded to a slope of 1 on 3 by means of hydraulic graders, and is then paved with stones laid upon a layer of spalls.

This type of revetment can be relied upon to hold the banks in the most difficult situations. It is manifestly not permanent in the sense that it will need no care after it is put in. Like most engineering or other structures, revetment must have constant care, but if properly placed in the first instance the cost of maintenance will not be excessive.

In New Orleans harbor the length of revetment is over five miles, some of which has been in place more than 20 years, yet there has been nothing expended in repairs and maintenance direct, other than that chargeable to plant and administration. This revetment con-

sists of spur dikes at intervals of about 450 ft., with standard revetment between.

The total length of revetment in place below Cairo to date is 39.6 miles. The repairs and maintenance, including all charges, varies in different localities, from less than 1% to about 5% of first cost. The latter figure may be regarded as quite excessive and will no doubt be largely reduced by the present methods of construction. Efforts are now being made looking to the development of longer field seasons whereby the plant can be used for a longer period each year, the result of which would be a material reduction of cost. Heretofore the field operations have been confined to the low-water season of three to five months.

The experience gained in this work is a most valuable asset, but it has been at the expense of much time as well as money, and the element of time is the more important of the two. Before a work can be looked upon with any degree of confidence it must pass through all the cycles incident to changes of stage, which necessarily requires many years, and this test cannot be hastened by any known means. But with the experience acquired by many trials, supplemented by careful, systematic observations, we can now proceed with confidence in our work, feeling sure that it will meet the requirements in a satisfactory way.

CHARACTER OF WORKS REQUIRED.

There will be no great difference of opinion among those who are familiar with the conditions as to the general plan to be followed in the development of a deep waterway below Cairo. The essential features must be, a combination of flood control by means of levees, bank protection, dredging and a limited amount of contraction work where the channel width is excessive. The proper use of such works will develop a deep-water channel at all stages of river throughout the lower two-thirds of the proposed "Lakes to the Gulf" waterway. In this reach the physical conditions are thoroughly understood, the means to be used have long since passed beyond the experimental stage and a fair estimate of the cost of a channel of such depth as may be required can be made from the data now in the possession of the Mississippi River Commission.

It would, therefore, seem to be good policy to begin systematic work on this reach at once, looking to the development of such depth of water as may be deemed necessary to meet the future demands of commerce. The organization is ready, a large portion of the plant needed is on the ground and it is only necessary to decide as to the limiting depth, when the work could proceed systematically on the lower thousand miles of the waterway pending the results of the elaborate investigations required for the 180 miles between St. Louis and Cairo.

Since the unanimous declaration of the Illinois legislature in favor of a bond issue for the construction of a deep waterway to the Mississippi River at Grafton, 329 miles from Lake Michigan, and the fact that good results are practically assured for the lower 1,070 miles below Cairo, it does not seem at all probable that such formidable obstacles to the proposed improvement between St. Louis and Cairo, 180 miles, will be met with as to seriously menace the practicability of the entire project.

The work required from Grafton to St. Louis with estimated cost has also been definitely determined. So, out of a total distance of 1,625 miles from Lake Michigan to the Gulf of Mexico, there are only 180 miles concerning which there is much doubt as to the best methods of securing the depth desired, and even in this limited reach there can be no reasonable doubt as to the possibility of securing such depth as may be required.

The opening of the Panama Canal should see the work on the deep waterway well on toward completion, and it would seem to be wise to begin work at once, since the proper line of procedure for more than two-thirds of the entire work is already quite clearly defined.

AMPLE TERMINAL FACILITIES ESSENTIAL.

The easy and expeditious transfer of freight at the great shipping centers is quite important. The lack of facilities therefor has been attributed to the difficulty of installing suitable terminals on account of the oscillations of stage in the river. The extreme range of stage recorded at St. Louis is 44 ft.; Cairo, 53 ft.; Memphis, 43 ft.; Vicksburg, 59 ft.; Natchez, 51 ft.; New Orleans, 21 ft.

While these conditions complicate the problem somewhat, there are no great difficulties in the way of designing and constructing fireproof warehouses along the river fronts which would greatly simplify the loading and unloading of boats and barges and provide for the interchange of traffic with the railways direct without the usual drayage.

Some years ago the writer suggested the construction of a series of warehouses along the river front at St. Louis, beginning at the Eads Bridge and extending downstream as far as necessary to accommodate the traffic, the warehouses to have several floors for the convenience of the water traffic, the surface and elevated roads, and goods that came by wagon, all to be provided with suitable elevators, which could shift loaded trucks from one floor to another, where they could be rolled away to the desired point of delivery. Suitable conveyors, inclined and horizontal, would also expedite the handling of freight. These warehouses were to be reached from the business portion of the city by elevated driveways, which would eliminate a large part of the steep hill between Third St. and the levee. The great value of such terminals to both water and rail traffic must be apparent.

The city of New Orleans has actively begun the construction of extensive warehouses and freight platforms along the river front, with a belt line of railway along the land side thereof, for the easy and rapid interchange of freight. Her example should be followed by other important shipping centers in order that the fullest benefits to be derived from water transportation may be realized.

At St. Louis and other points, wharf boats rising and falling with the stage of river have been in common use, but the drayage over the steep levee has always been a serious drawback. This method does not permit of a direct interchange of freight with railways, as the wharf boat moves laterally along the slope of the levee as well as vertically, as the stage of the river changes.

Warehouses, called elevators, for handling package freight, were formerly used with success at Memphis, Vicksburg and Natchez; and at New Orleans conveyors are now used to carry the freight to the top of the wharf or levee.

For facilitating loading or unloading at way landings, river craft should be provided with conveyors attached to the stage plank so that freight could be landed at the top of the bank without using the great amount of time and labor incident to present practice.

Where the cargo is destined to foreign ports, the transfer can be made direct from river to seagoing craft, and in this way storage and warehouse charges would be materially reduced.

Improvements of the kind named are next in importance to better channel conditions and in a general revival of river traffic should receive the fullest consideration.

VALUE OF WATERWAY AS A TRANSPORTATION HIGHWAY.

As the deep-water project proposed will involve the expenditure of large sums of money, it is proper to inquire as to what benefits may be expected to accrue by its construction and use. Before any project is adopted, it should be pretty clearly established that the sum of all the benefits will be fully commensurate with the cost. When this has been satisfactorily settled, the cost of the project, though great, becomes a matter of secondary importance.

In a project of such great magnitude, these questions of cost and value, especially the latter, cannot be determined with any great degree of exactness. The same thing is true to a certain extent of all great engineering works,—the Suez Canal, the Manchester Ship Canal, the great transcontinental railways, the New York subways. In all of these cases the benefits that justified the works could only be roughly estimated when the projects were undertaken, and in nearly all of them the estimates of the benefits were altogether too conservative. And if is not improbable that the value of a trunk line waterway of great capacity, such as proposed, will also be underestimated even by its most enthusiastic advocates.

The writer devoted considerable time to gathering statistics of the freight movement by river and by rail from the port of St. Louis for the years 1865 to 1900. These data were published in the report of the Mississippi River Commission for the year 1901 and have been widely quoted since that time.

The grain traffic by river did not assume important proportions until 1877, owing to the general belief that grain exported by the way of the warm, humid Gulf route would be damaged in transit, although the St. Louis Grain Association virtually settled the matter in 1869 by sending 500,000 bushels of wheat to Liverpool, which reached its destination in good order. The lack of depth at the mouth of the river prior to the construction of the jetties was also a serious drawback.

The maximum rate on wheat by rail from St. Louis to New York reached 72 cents per bushel in 1867. In 1877 the rate was 24.6, and in 1900 11.6 cents per bushel, as against 8¼ cents in 1877 and 4¼ cents in 1900 from St. Louis to the seaboard at New Orleans.

From the exports for 18 years, 1883 to 1900 inclusive, for which complete data are available, some interesting deductions may be made. The total number of bushels of grain exported from St. Louis during this period was 761,004,715 bushels. The average rate per bushel, St. Louis to Liverpool by river and Gulf route, was 6.85 cents less per bushel than that by rail via Atlantic ports. Applying this to the total amount exported, and we have the magnificent sum of $52,128,882.98, which might have been saved to the producer and shipper had the grain been carried by the river route. The river did actually carry 134,736,563 bushels of export grain during this period, showing an actual net saving over the rail rates of $9,229,4[illegible] this from a single port on the river and for a single [illegible]mmodity.

Add to this the shipments that were [illegible] of coal, lumber, cotton, sugar and general merch[illegible]e to and from this and many other ports through[illegible]he length of the river, and we get some conception of [illegible]enormous value of the Mississippi River as a comm[illegible] highway under such improved conditions as would [illegible]re ample depth at all times.

Two illustrations will perhaps serve to [illegible]asize the possibilities of river traffic. The steamer [illegible]rague," a stern-wheel towboat of the Mississippi R[illegible]type, has recently taken down at one time a cargo [illegible],000 tons of coal. A recent report of the Frisco Railr[illegible] gives the average carload for the past year at 1[illegible] tons, and train load, 224.4 tons. On this basis it [illegible]d require 3,965 cars or 298 trains to haul the single [illegible]go named.

A notable cargo on a single hull was [illegible]t of the "Henry Frank," which carried 9,226 bales o[illegible]ton and a quantity of cotton seed at a single load. [illegible] hull of this boat was 267 ft. in length, with a b[illegible] of 52 ft. This single cargo would make about 300 [illegible]ds. Both of these cargoes were carried at high stage[illegible] of river, but they afford good illustrations of what might be done with an improved waterway with sufficient depth at all seasons.

There is a wrong impression in the popular mind as to the relative speed of transportation by water and rail. The "Sprague," with her immense cargo in barges, would make 75 to 100 miles per day, or about four times the average speed of freight movement by rail, as given by a high railway authority. A cargo on a single hull would easily average 150 miles or more per day. The usual time for a tow of grain barges carrying about 12,000 tons, or say 54 average train loads, from St. Louis to New Orleans, is 8½ days, or an average of 140 miles per day, over five times the average rate of freight movement by rail.

Whatever may be the type of boat that will ultimately ply between the principal ports and the seaboard through a deep waterway, the way landings must continue to be served in a large measure by boats and barges similar to those now in use.

An improved waterway which would develop to the highest degree the possibilities of water transportation would largely solve the question of freight congestion under normal business conditions, which has become a matter of such serious concern to railway managers. As an illustration of this congestion, it is related that an English firm of spinners bought last year at Memphis some 5,000 bales of cotton to be shipped to Liverpool via Atlantic ports. Such was the dearth of cars that the cotton remained in storage three months before it could be started on its way.

The waterway must supplement the railway by relieving it of a large volume of the low-class freight, such as farm products, coal, lumber, minerals and building material, leaving the manufactured products and higher class freights to the railways. Raw material can be moved cheaper by water than by rail, and much that would otherwise remain inert would be brought into use to be developed into manufactured products, the distribution of which would result in increased revenues to the railways. So it is by no means unreasonable to assume that an efficient waterway will be of substantial benefit even to the railways.

SPECIAL ADVANTAGES OF THE ROUTE FROM LAKE MICHIGAN TO THE GULF OF MEXICO.

First. Its whole length lies in the very heart of the most productive section of the entire country.

Second. The great capacity of three-fourths of its length as a transportation highway is without a parallel. As compared to the greatest artificial highway, it has practically unlimited capacity.

Third. Its situation as to closure by ice gives it a very decided advantage over any of the northern routes proposed. One thousand miles of its length is open to navigation practically the entire year. Even between St. Louis and Cairo the river was open 20 out of 43 years, and the closure on account of ice in the most severe winters has never exceeded 59 days. The northern routes are generally closed more than twice that length of time each year.

Fourth. The volume of water available under natural conditions, which is essential to the development of any satisfactory waterway, is far greater than that of any other route, and its capacity for improvement is proportionately greater.

Fifth. The proximity of the Gulf end of the route to the Panama Canal and the consequent advantage in trade with the Pacific coast and the Orient, as well as the accessibility of the South American countries, gives this route a great advantage over any other in this particular field of trade and commerce.

Sixth. Its construction, in proportion to its available length and capacity, will probably cost less than any other route.

Seventh. Nature has marked a route of unequaled utility and value along the thalweg of the Mississippi Valley which the skill of the engineer can readily bring under subjection for the profitable uses of man.

THE TEN-STORY REINFORCED-CONCRETE HOSTETTER BUILDING, PITTSBURG, PA.

In our issue of Nov. 7, 1907, p. 488, we described and illustrated a 10-story building, the Gloekler Warehouse in Pittsburg, which was not only of reinforced-concrete frame but also finished and decorated with concrete facing. There has recently been completed in the same city another reinforced-concrete building of the same type and practically of the same size, but of an entirely different external appearance and with some different features of construction. The Hostetter warehouse, a view of which is shown in Fig. 1, is 10 stories and 126.5 ft. in height, with an 11-ft. basement, but instead of a concrete facing, the exterior is mainly of vitrified brick with terra cotta and sheet-metal ornamentation. Instead of the unit frame reinforcement of the Gloekler building, it is reinforced with round rods placed to the correct position in the forms as built.

The Hostetter building is on a plot of land 160 x 60 ft. in plan, immediately adjoining the eastern approach of the large cantilever bridge carrying the Wabash R. R. across the Monongahela River, so that siding facilities from the bridge to the fourth story of the building have been provided. The construction is the usual beam and girder type, resting on columns bearing on spread footings to a good gravel foundation. The side walls are all facing walls bearing at each floor on the concrete beams which appear on the surface. No partitions are carried up in the interior of the building except those of fireproofing tile around the elevator shafts. On one side, the wall columns had to be cantilevered a short distance, 2 ft. 6 ins., from the footings in order to clear the foundations of an adjoining building which could not be disturbed.

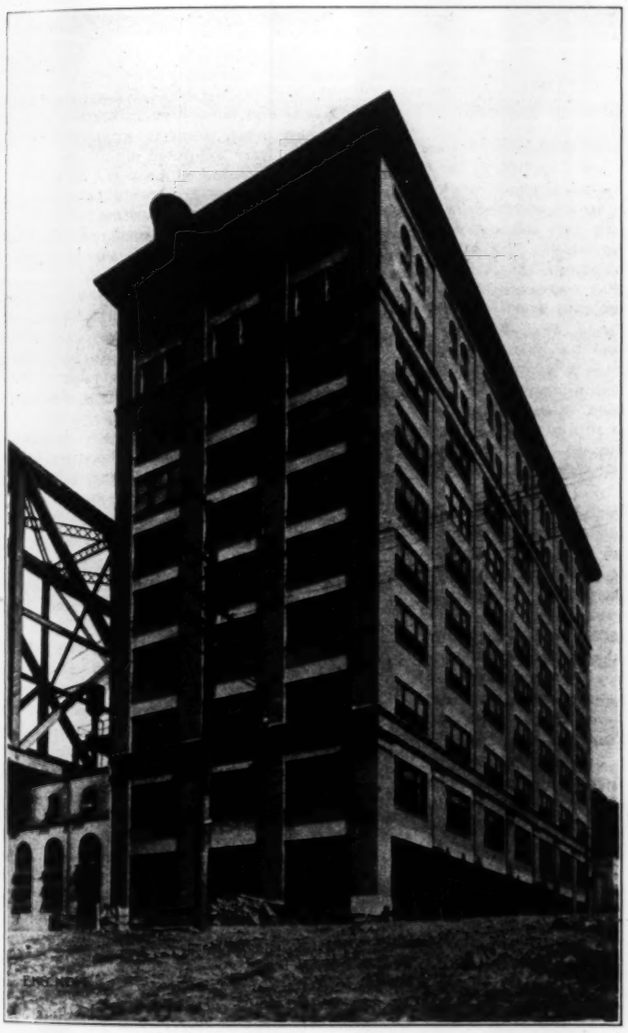


FIG. 1. THE HOSTETTER REINFORCED-CONCRETE WAREHOUSE IN PITTSBURG, PA.
(Designed by C. F. Walthers & Co.; Erected by A. & S. Wilson Co.)

The columns were spaced at the corners of bays 22 ft. 6 ins. by 18 ft. 8 ins. and were founded on square block concrete footings and connected thereto by the cast iron bases shown in Fig. 2. It will be noted that these bases are provided on their tops with nipples to which are connected by pipe sleeves the reinforcing rods of the columns. The columns vary in size from 26 × 26 ins. at the basement to 22 × 22 ins. at the roof and in reinforcement from eight 2⅜-in. straight round rods to four of the same size. These rods are held together as shown in Fig. 2 by wires spaced about every 12 ins. The specification for these columns reads as follows:

> The compression bars in the columns are to be tied diagonally across with 3/16-in. steel wire at intervals of their distance apart, and to rest and be securely connected with sleeves to nipples on standard bearing castings, the bottom area of which must not be above 350 lbs. per sq. in. compression on concrete.

The girders are spaced 22 ft. 5 ins. on centers and vary in size from 14 × 28 ins. to 12 × 26 ins., and the beams are spaced about 10 ft. on centers and vary in section from 12 × 26 to 12 × 24 ins. The reinforcement throughout varies with the load and is made up of separately placed round rods bent up at the columns and along the beams to form stirrups. The floors are either 4 or 5 ins. thick and reinforced with ¾-in rods spaced 12 ins. c. to c. and crossed with ½-in. rods 6 ins. c. to c. The roof is a combination of fireproofing tile laid on a reinforced-concrete slab and covered with tar paper and asphaltum in which are embedded slate.

Although no especial waterproofing features were provided in the cellar, the building passed through the record flood of March, 1907, without having any water in the lower part, although the river was at one time within 2 ft. of the first floor level.

The design was made for the following loads: 300 lbs. per sq. ft.—Floors 1-4; 250 lbs. per sq. ft.—Floors 5-10; 75 lbs. per sq. ft.—Roof. Allowable stresses were 500 lbs. per sq. in. for flexural concrete; 50 lbs. per sq. in. for concrete in shear and 350 lbs. per sq. in. for concrete in direct compression, using steel with an elastic limit of 50,000-60,000 lbs. per sq. in. Especially rigid tests were specified as to test loading, it being required that each floor stand twice the specified load without permanent deflection.

In the first test of the floors cement bags were used to weight the floors. The third floor was subjected to a weight of 500 lbs. per sq. ft. on one bay, no deflection being apparent in this test. This test was witnessed by the inspector for the owner and pronounced satisfactory, and no further test required. Upon request, however, a second test was made about six months later on the first, fourth, sixth and tenth floors, the lower floors having 125 tons and the upper floors 104 tons of pig iron placed upon one bay on each floor. The load was laid upon 2-in. planks, making a total of 600 lbs. and 500 lbs. per sq. ft. respectively, called for by the specifications. As a result of this test the total deflection was 5-32-in. The advisability of submitting the floor to such a severe strain has been very much questioned, but as the test was asked for, it was made with entirely satisfactory results to all parties concerned.

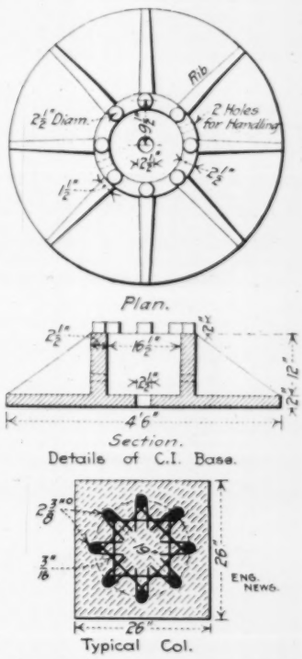


Fig. 2. Column Reinforcement and Cast-Iron Base, Hostetter Bldg., Pittsburg.

The method of recording the deflection was by placing rods on the floor below, set up under the girders and beams, two rods fastened with wires so that any compression caused the rods to slide on each other, the marks made upon the face of the rods showing any movement. The pig iron was unloaded from the car onto the fourth floor which was first tested, then moved by wheelbarrows on the elevators to the other floors. This iron was handled in making the tests at 12 cts. per ton per floor.

The plans for the Hostetter Building were originally drawn by Charles F. Walthers & Co., who were given the contract for the construction of the building. This contract was later transferred to the A. & S. Wilson Co., Mr. Walthers, of the above firm, being retained as supervising engineer on construction. The design was checked by Mr. F. H. Kindl, Mr. A. F. Hoffman and the late Carl Schinke, all of the Wilson Co. Mr. F. B. Denman was superintendent and Mr. Hoffman, engineer of construction for the contractors. We are indebted to Mr. James S. Haring, M. Am. Soc. C. E., of the A. & S. Wilson Co., for the information and illustrations contained in this article.

THE REFUSE DESTRUCTOR AT SEATTLE, Wash., has now been in operation for some weeks. It is in part the outcome of a recent trip abroad of Mr. R. H. Thomson, M. Am. Soc. C. E., City Engineer of Seattle. Plans for the destructor were bought from Meldrum Bros., of Timperly, near Manchester, England, and Mr. William Mortimore, one of the engineers of that firm, was engaged to go to Seattle and cooperate in building the plant. The destructor is of the Meldrum front-feed type, has four cells and an offal chamber, and is similar in all respects to the plant at Nelson, England. Mr. Thomson informs us that the Seattle destructor is giving satisfaction, and that two others, similar in type, may be built before long. Meldrum destructors at Watford, England, and at Westmount, P. Q. (near Montreal), were described in Engineering News of April 20, 1905, and May 24, 1906, respectively.

THE SPRING MEETING OF THE AMERICAN ELECTRO-CHEMICAL SOCIETY.

(Concluded from page 513.)

Mr. Richard H. Gaines, Chemist, Board of Water Supply, New York City, presented extracts from a report which he has recently made on the corrosion of the steel conduit furnishing water supply to Rochester, N. Y. We shall print this report of Mr. Gaines' in an early issue.

Mr. E. R. Taylor, of Penn Yan, N. Y., in a paper entitled "Forestry, Water Storage, Power and Navigation," directed attention to the current agitation for reforestation and flood prevention. He particularly claimed that however advisable reforestation was, it must be accompanied by proper impoundage before floods could be prevented, power could be utilized or navigation benefited.

A PHYSICAL CONCEPT OF THERMODYNAMICS.—The second day's sessions were held at one of the chemical laboratories of Union University, Schenectady, and the feature exciting the most interest was a lecture by Dr. C. P. Steinmetz on "Kinetic Molecular Energy." He introduced his subject by stating that he would try to present some mental pictures or some physical conceptions of thermodynamic laws which were ordinarily difficult so to comprehend and to some extent were looked upon as mere mathematical expressions of results attained and not indicative of an actual process.

He held that however the nature of heat energy might be considered, it certainly exhibited all the characteristics of an irregular molecular motion, resulting from the action of "central forces" (gravitation or whatever they might be termed) on minute bodies at considerable distances apart, compared with their diameters. This would be analogous to the action of "cosmic forces" on stellar bodies in the solar systems. By mere considerations of such irregular motions, he derived in outline the more important thermodynamical expressions. A few of the steps outlined are very briefly shown in what follows. If matter is considered as composed of molecules in motion, then each molecule may have a velocity with or against any force acting on it. This may be pictured as arresting or accelerating its motion so that if by the theory of probabilities there are as many accelerating as retarding influences, then the molecules take up an oscillatory motion. The molecules may be held as seldom acquiring sufficient velocities to carry them outside of their present spheres of inter-influence. Hence the substances composed of such molecules have constant volume, form and solidity, and are termed solids. It is conceivable that when the molecular velocities have been caused to rise high enough that a molecule may pass out of one "sphere of influence" into another and that the path of such a molecule at any instant of consideration is a portion of a closed curve or orbit about some other molecule. When all the molecules of a substance so wander it loses its continuity of form and solidity, but retains its constancy of volume and is called a liquid. In this state the action of the molecules under "central forces" is analagous to that of solar bodies traveling on elliptical paths about the sun under the influence of "cosmic forces." However, when this molecular velocity is exceeded the molecules assume parabolic or hyperbolic paths; leave closed for open orbits. Then the substance loses its constancy of volume and develops a pressure or is said to be in a gaseous state. Thus the conceptions of matter under increased temperatures are developed from considerations of irregular molecular motions without the need of irrational assumptions such as that of the collision of perfectly elastic spherical molecules. There is no more collision here than there is of comets and planets with the sun.

From such primary considerations were deduced the thermodynamic expressions. The condition of a body as a solid, liquid or a gas depends on its temperature, but from this concept it depends on the velocity of molecular motion and it may be held that,

$$T \propto \tfrac{1}{2} m v^2$$

using these symbols in the commonly accepted meaning. If now n denotes the number of molecules of a gas in a unit volume, the pressure exerted by a gas on a boundary follows this physical concept as

$$p \propto n m v^2$$

and substituting in the previous expression

$$p \propto n T.$$

That is, the pressure of a gas is directly proportional to the absolute temperature. Remembering that the total displacement of a given weight of gas must be inversely proportional to the molecules per unit volume

$$V \propto \frac{1}{n}$$

then there results;

$$p \propto \frac{T}{V}$$

from which is evolved the familiar

$$p V = R T.$$

When the boundary of a gas is moving out (gas expanding) the velocity of a molecule returning from contact with the boundary is relatively less than the value when approaching so that its $\frac{1}{2} m v^2$ is reduced or the temperature is lowered. This is the concept of adiabatic expansion.

Following still the analogy of cosmic forces, the laws of stellar motions when applied to these molecular motions indicate that there is no exchange of energy when two bodies approach each other, but that there is an interchange when three or more molecules approach. The kinetic energy is redistributed, although the total $\frac{1}{2} m v^2$ remains constant. The increased velocity given a molecule may cause it to break open its orbit, in the case of a liquid, to a hyperbolic path which carries it beyond the surface of the liquid and it escapes. This is evaporation at temperatures below the boiling point. In this manner might all the points taken up in this most interesting address be run over, yet enough has been superficially indicated to explain the main line of thought and analogy assisting this concept.

THE METALLURGY OF ALLOYS.—Much of the last session, at the Rensselaer Polytechnic Institute in Troy, was taken by discussion of the metallurgy of alloys, particularly of aluminum. The leading paper on these topics perhaps was "The Preparation of Calcium Alloys for Aluminothermic Work" by Messrs. O. P. Watts and J. M. Breckenridge, of the University of Wisconsin. This paper related how, in experiments on the reduction of vanadium, manganese, titanium, tungsten and tantalum alloys, where it was not desired to use the electric furnace, that the temperatures obtained by the Goldschmidt reactions were not high enough. Then it was undertaken to gain the desired additional heat by using materials having a greater heat of combination per unit of charge than was obtained previously from aluminum with the proper oxides and by having the resultant slag more easily fusible. It was also desirable to cheapen the manufacture of charges for all such aluminothermic work, and it was stated that the cost was largely due to the trouble and expense of granulating. The cost of granulated aluminum now is approximately $1 per lb. The investigations were therefore, made with the additional end of securing an alloy that would be easily pulverizable. Aluminum, calcium, magnesium and silicon were studied in numerous combinations by alloying them in an electric furnace. The solution of calcium in aluminum was marked by the violent ejection of a large part of the alloy from the crucible. However, the addition of silicon rendered the action quiet and alloys were easily obtained up to 70% calcium. These were brittle and easily reduced to a fine powder. Moreover, desired improvement in the quantity of heat released and slag fusibility was obtained to such an extent that studies of the refractory elements could be prosecuted. Among [illegible] tions of these alloys, in mixture [illegible] oxides, was named a substitute [illegible] magnesium as a "flash powder," [illegible] graphic purposes, giving a more in[illegible]

"The Alloying of Iron and Calcium [illegible] title of the paper of Messrs. A. H[illegible] Ashton, of Madison, Wis., in which [illegible] scribed some successful attempts [illegible] these two metals by a metallo-ther[illegible] between calcium chips and iron ox[illegible] found that calcium rendered the iron [illegible] tle and destroyed its welding proper[illegible]

Professor A. T. Lincoln, University [illegible] Illinois, reported some researches on the [illegible] ctrolytic corrosion of bronzes, in artificial [illegible] water, which were an extension of similar [illegible] searches reported a year ago. In these latest [illegible] periments solutions of sodium chloride, etc., were [illegible] employed as electrolytes. The new results [illegible] exactly similar to those reported before; a [illegible] rease of corrosion was noted with a decrease [illegible] copper in the alloy. (See the report of the [illegible] eleventh general meeting of the American Electrochemical Society, Engineering News, May [illegible], 1907.)

Mr. J. W. Brown, Director, Research Laboratory of the National Carbon Co., Cleveland, [illegible] demonstrated the waste of electrical energy in gas and gasoline engine ignition due to the reliance arrangement of equipment; batteries, spark coils, contactors, etc., compared with a system where the electrical dimensions of apparatus, allowable currents and number and duration of sparks per explosion were properly inter-related. Two such systems were exhibited simultaneously, one of which was considered properly designed, the other made up from apparatus collected somewhat at random and representing current practice. In this particular instance the energy consumption in the latter system was stated to be four or five times that in the former on account of an unnecessary number of sparks per explosion and an inefficient relation of dimensions and currents in sparking transformer.

In the foregoing summaries, an attempt has been made to show the subject matter of only those papers of most immediate engineering value rather than purely scientific interest. The large number of papers and the restrictions of space here make it necessary, therefore, to completely neglect many discussions of interest to electrochemists.

THE MANAGEMENT OF THE BLACK LOCUST PLANTATIONS OF THE PENNSYLVANIA RAILROAD.

By E. A. STERLING.*

Since 1902, the Pennsylvania Railroad Co. has established some forty plantations of black locust (Robinia pseudacacia) along its main line and branches between Coatesville and Altoona, Pa. The aggregate number of locust trees planted is approximately 1,855,000, the area occupied being in the neighborhood of 2,000 acres. In addition 272,500 trees of other species were planted in the spring of 1907. This is probably the largest acreage and the greatest number of forest trees set out by any organization in the United States outside of the National Government.

The primary object in inaugurating this work was to produce wood material suitable for railroad purposes, and at the same time to utilize the company's idle land and give an object lesson in forest planting. It was really the beginning of the company's forest policy, and while it is obvious that planting alone will not solve the problem of timber supply for any large corporation, the planting of forest trees and the management of plantations is bound to remain an important line of work.

The poor form-development of black locust, its decline in rate of growth after the fifteenth or twentieth year, and the damage by insects, particularly the locust borer (Cyllene robiniae) have made it very apparent that it will not be advisable to continue the planting of locust in pure stands. In future planting operations such trees as red oak, pin oak, chestnut, Scotch pine, red pine and European larch will be used on the sit-

*Forester, the Pennsylvania Railroad Co., Broad Street Station, Philadelphia, Pa.

uations to which they are best adapted. Although their rate of growth is not so rapid up to sapling or pole size, the average annual increment at financial maturity will be greater than with locust, while the wood will be adapted for preservative treatment, which, it is safe to assume, will be given to all timber by the time the trees are mature.

The management of the existing locust plantations so as to secure the highest net returns on

LOCUST PLANTATION OF THE PENNSYLVANIA RAILROAD.
[These trees were set out in 1902. They are spaced 10 × 10 ft. each way.]

the investment already made is a question of interest to foresters, and closely related to general railroad forestry. A study of the plantations has revealed rather clearly the best general principles for their management. There is, however, so little to follow in the way of precedent that excellent opportunity is given for working out many experiments which will conclusively demonstrate the best scheme of management.

The plantations as they stand present a wide range of conditions, from a full stand of vigorous, fast-growing trees to almost total failure, according to their age, location and spacing. The oldest trees, which were planted in 1902, average from 15 to 20 ft. in height, with diameters varying from 3 to 5 ins., while the trees in the 1906 and 1907 plantations range from 3 to 6 ft. in height. The spacing varies from 10 × 10 ft. to 4 × 4 ft. each way. Insect damage is almost universal, it being difficult in many of the plantations to find a tree which does not harbor the locust borer (Cyllene robiniae), while secondary insects, particularly the twig borer, Ecdytolopha insiticiana, are putting in an appearance. In many cases the borers have not seriously injured the trees, but their presence in the twigs leaves little hope that the main trunk will reach maturity without becoming infested. The form-development of most of the trees is unsatisfactory, the tendency being to fork near the ground and form a spreading top with many persistent limbs along the main stem. This is due in part to the wide spacing and to the killing of the terminal shoot by the twig borer, coupled with the thin foliage and light-demanding nature of the species. The thin foliage also permits the growth of grass and weeds under the stands, and precludes the natural formation of ideal conditions of canopy and forest floor.

Two fundamental steps are obviously necessary in improving the present locust plantations. The first is the substitution of other species for the locust on wet ground and on other situations to which it is not adapted and has failed; the second, underplanting the remaining portions of the plantations with suitable species, in order to bring about proper conditions of canopy and soil cover, force the locust into better form-development, and establish the basis for a future stand of maximum volume and value.

Pruning to improve the form of the trees, aside from the high cost, fails of its purpose at their present stage of development, and is inadvisable because within a year or two new limbs entirely replace those removed, and the temporary opening up of the crown cover gives added encouragement to grass and weeds, and instead of stimulating height growth throws the energy of the trees into the development of lateral branches. Cultivation of the soil until the crowns close up, in order to keep down vegetation and prevent soil evaporation, would be of theoretical advantage, but it is too expensive for consideration; moreover, these ends should be early attained by creating a crown cover of sufficient density.

In replacing such of the locust as has entirely failed the main consideration is to use trees which will thrive on the particular site under treatment, and for ordinary moist situations pin oak or tamarack promise the best results. In underplanting, not only must the species selected be first of all suited to the local conditions of soil and aspect, but, in addition, they must be sufficiently tolerant of shade to thrive where the locust has already formed a partial cover. In the rather open or widely spaced stands of locust, either red oak, Scotch pine or chestnut meet these requirements; where there is more shade, Norway spruce or white pine are about the only species which can be safely used. The number used per acre will depend on the original spacing of the locust. Where the locust is planted more than 6 × 6 ft. apart each way, the introduced species can occupy the fail places and the centers of each square, or if the original spacing was 10 × 10 ft., planting can be done between the rows and between each individual tree, thus giving a spacing of 5 × 5 ft. in the proportion of one locust to four of the other species; where the spacing is 6 × 6 ft. or less, underplanting should ordinarily be done only where the locust has failed and in the alternate squares of each row, otherwise root competition and the demands for crown space will be too severe. Species other than those mentioned will be tried experimentally, the list including red pine, European larch, hardy catalpa, black walnut and yellow poplar. Pruning in a few of the dense stands may be found helpful in giving the necessary light and space for the newly planted trees.

The scheme of underplanting outlined is intended to increase the density of the present locust stands, crowd off the lower branches and stimulate height growth, thereby improving the form development; keeping down excessive growth of grass and weeds and thus bettering the soil conditions; and forming the basis for a permanent crop after the locust is removed. It is expected that the locust will maintain its lead in height, the associate species forming an understory. After these conditions are produced, the next step will be thinning, the insect-infested and otherwise undesirable locust being removed when the first improvement cutting is made. Most of the remaining locust will be cut in 15 or 20 years, as soon as they are large enough to market for posts or pin wood, and at the same time the overtopped trees of the understory will be removed. This will leave the few locust trees which promise to attain tie size and the dominant trees of the other species as the basis for the final cutting, which is expected to take place in 35 to 40 years from the time of planting.

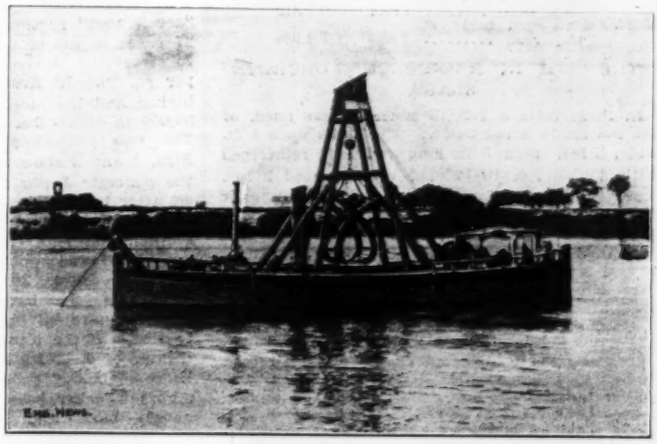
The principles outlined above hold in setting out new plantations, and while it is obvious that locust should not be grown in pure stands, it may safely be used in the proportion of one to three with other species, with the expectation of removing it at the first thinning. The advantage of this would lie in the cheapness of locust planting material, in the function it would perform as a "filler" among the other trees, in its rapid growth during early age, and the value of small-sized trees for posts and insulator pin-wood.

STONE-LIFTERS USED ON THE RIVER ST. LAWRENCE SHIP CANAL.

In the accompanying cut is an illustration of one of the stone-lifters now in use on the dredging work in the River St. Lawrence Ship Canal, which was described in an article in our issue of Jan. 30, 1908, p. 111. There are two of these boats in use on the work to remove boulders which are too large for a dredge to lift or to clear the bottom before the dredge is placed to work at any locality. As can be noted from the cut, the lifter consists of a wooden-hull boat with a middle well through which the large 60-ton capacity tongs or grips can descend to the river bottom, there to pick up boulders which can be hauled to the deck by the hoisting engine situated aft. The larger of the two boats has the following dimensions:

Length over all	108 ft.
Breadth of beam	34 ft.
Depth of hold	14 ft.
Dimensions of well	22 × 12 ft.

The cut and information are reproduced by courtesy of the Department of Marine and Fisheries of Canada.



LARGE STONE LIFTER IN USE ON RIVER ST. LAWRENCE SHIP CANAL.
(Grips capable of lifting 50-ton boulders.)

A RAIL-GROOVE BRAKE, the invention of Mr. P. J. Pringle, Borough Electrical Engineer and Tramway Manager of the Burton-upon-Trent Corporation, is described in the (London) "Electrician" of May 1. This is an emergency mechanical brake additional to and entirely independent of any other equipment on the car. It is instantaneous in action and has no gradations; when applied it must be at maximum braking effort. No expenditure of power or sand is required for its application. A malleable-iron bracket is attached to the truck frame, inside the wheel base and close to each wheel flange. This bracket supports, through a compression spring and pair of links, a malleable iron block carrying a renewable manganese-steel skid shoe of a shape to conform to the rail groove. The brake is held away from the track by a steel wire or cable so that when this is released the compressed spring forces the skid bar into the groove. The brake block also engages the wheel flange and is forced downward with additional pressure. Only the brakes on the rear wheels are released. On this tramway the operation of the new type is considered satisfactory and successful.

TESTS OF CORAL SAND AND ROCK WITH REFERENCE TO THEIR USE IN CONCRETE.

By DEWITT C. WEBB,* Mem. Am. Soc. C. E.

The following tests of coral sand and rock may be of some benefit to engineers who are located, as the writer is at present, where the only available local material for concrete aggregate is of a coraline nature. The so-called coral sand to which these tests refer is simply pulverized coral, varying from fairly coarse to very fine. The rock is evidently coral which has been broken, compacted and cemented by the action of waves and weather, and most of it is so soft and friable as to be entirely worthless for concrete. Much of the surface layer or "plate" as it is called, 6 ins. or more thick, is comparatively hard but the principal source of the concrete rock used in Key West is loose surface stone ranging in size up to 1 cu. ft. or more. These are evidently the harder portions of a former "plate," the remainder of which has weathered away.

The tests have been made on weights and percentage of voids of the coral rock and upon the tensile, crushing and flexural strength of concrete mixed with the coral as aggregate.

WEIGHTS AND VOIDS.

Material.	Weight per cu. ft.	Per cent. of voids.
Coarse coral sand	71	52
Fine coral sand	87	38
Broken coral rock—2½-in. diam.	65	52
Unbroken coral rock	125-150	..

Absorption of broken coral rock was 10% in 10 min.

TENSILE STRENGTH.

The first of these tests shown in Table I. were made in 1898 at Dry Tortugas, under the direction of Civil Engineer A. J. Menocal, U. S. N.; the second set were made under the direction of the writer at Key West in 1907. Both tests were made on briquets composed of 1 part Atlas cement and 3 parts coral sand.

CRUSHING STRENGTH.

The tests for crushing strength were made by the Department of Steam Engineering, U. S. N., Navy Yard, Norfolk, Va., May, 1907, on 6-in. cubes of 1:3:6 concrete. The cubes were about 75 days old when tested.

No. of tests.	Aggregate.	Water.	Average ultimate crushing strength in lbs. per sq. in.
2	Coarse coral sand and coral rock	Fresh	673
5	Coarse coral sand and coral rock	Salt	516
5	Fine coral sand and coral rock	Fresh	764
5	Coarse coral sand and trap rock	Fresh	842
3	Fine coral sand and trap rock	Fresh	1,686

STRENGTH IN REINFORCED-CONCRETE SLABS.

In these tests a 1:2½:5 concrete was used, of the materials noted below. The slabs were 1 ft. wide, 3 ins. thick, 3 ft. long and were reinforced with double No. 10 twisted wires spaced 2 ins. c. to c. The load was applied uniformly over 27 ins. with the supports 23 ins. apart.

SLAB NO. 1:

Coral sand and selected cinders. Wgt. per cu. ft., 123 lbs. No appreciable deflection until a load of 1,073 lbs. per sq. ft.

SLAB NO. 2:

Coral sand and unselected cinders containing much coke and unburned coal. Wgt. per cu. ft., 96 lbs.

Load per sq. ft.	Deflection.
222	very slight
442	.025-in.
1,064	.041-in.
1,267	.062-in.

Very slight permanent set when load was removed.

*Civil Engineer, U. S. Navy, U. S. Naval Station, Key West, Fla.

IMMUNITY FROM RUSTING OF REINFORCING STEEL IN CONCRETE.

The much-mooted question whether the steel reinforcement in beams of reinforced-concrete is in danger of rusting by the entrance of air and moisture through the inevitable tension cracks has recently been studied by Mr. E. Probst in tests* made at the Prussian Royal Testing Institution at Gross-Lichterfelde West, Berlin, Germany. They give practically the first experimental showing that the ordinary tension cracks (occurring within the limits of permissible loading) do *not* permit the atmospheric corroding influences to affect the steel; they indicate that rusting by entrance of air and moisture is to be apprehended in cases where the stress in the steel has passed the elastic limit and in consequence has opened relatively wide cracks, but not in cases where the stresses are well below this. Tests of 32 beams by an "accelerated" rusting test showed no rusting in 27 cases in all of which the load was such as to stress the steel to from 18,000 to 35,000 lbs. per sq. in. In five tests, where the load was higher and the steel was stressed to values of 35,000 to 44,000 lbs. per sq. in., rusting resulted. The two photographs reproduced herewith as Figs. 1 and 2 show a case of maximum rusting, the concrete below the steel having been split off after the test in order to expose the steel.

The test beams were 6.3 × 8.6 ins. in cross-section, and long enough to give a span of 59 ins. Load was applied at two points equidistant from the center, 20 ins. apart. The reinforcement was five bars each equivalent to about $^{5}/_{16}$-in. square, giving percentages equal to 1.03 to 1.31% of the total area above center of steel (center of steel 1¼ ins. above bottom of beam). In some beams plain round rods were used, in others Thacher bars, in others Johnson (corrugated) bars, and in others Ransome (cold-twisted) bars; but the last-named were used as plain square bars and were twisted in the laboratory. The concrete was mixed in 1:2:4 ratio (¾-in. broken limestone), using sufficient water to give a quite plastic mass, which was subsequently found to be 10.1% of weight. The steel was carefully cleaned of rust before it was placed in the concrete. Forms were removed after 24 hrs. Some of the beams were stored in air, being sprinkled every day for the first ten days; others were stored under a foot or two of moist sand which was sprinkled every day.

The beams were subjected to load tests at ages of three to six months. They formed part of a series of tests to determine point of first cracking, deflection, stress in concrete, stress in steel, and ultimate strength. Of 58 beams, only 26 were tested to rupture, while the others were tested to a point below (or just at) the elastic limit of the steel, and these were later subjected to the rusting test.

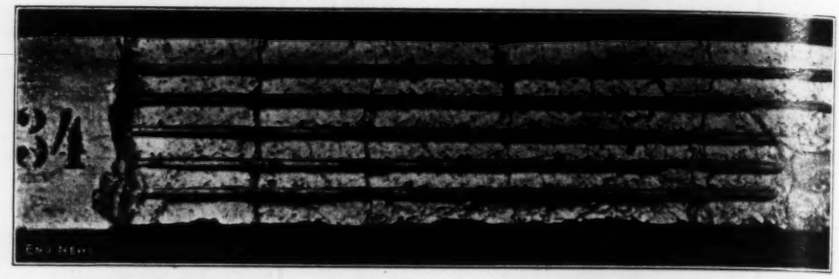


Fig. 1.

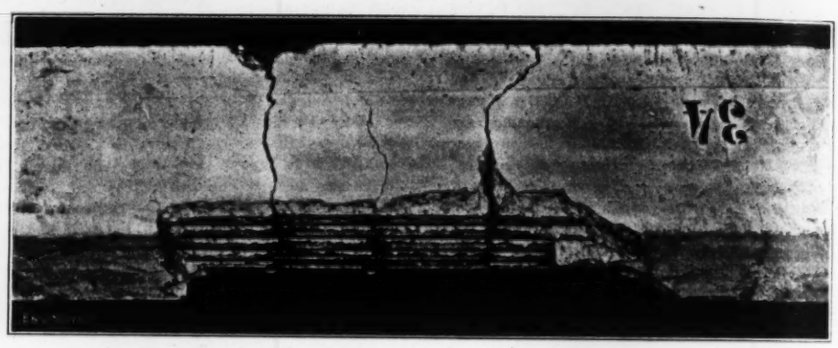


Fig. 2.

FIGS. 1 AND 2. TWO VIEWS OF BEAM, SHOWING APPEARANCE OF STEEL AFTER THREE DAYS' EXPOSURE IN RUSTING TEST; BOTTOM LAYER OF CONCRETE SPLIT OFF TO SHOW APPEARANCE OF STEEL.

The rusting test apparatus comprised a lever arrangement for applying a fixed load to the test beam (at two points), a tight sheet-iron casing around the beam over the middle third of its length, and apparatus for leading a current of mixed carbon dioxide, oxygen and water vapor through the casing. The water vapor was produced by a small boiler heated by a Bunsen flame, while the two gases were drawn from tanks of pure gas, discharging through reducing valves and water bottles to permit of close regulation and sight feed.

The test beams, as already noted, had previously been subjected to loads sufficient to bring into play the tensile strength of the steel and open the ordinary tension cracks in the concrete which occur beyond the lowest stage of loading. After being placed in the frame for the rusting tests, a constant load was applied which was in most cases nearly the same as the maximum load previously applied. The casing was then put on and the current of corroding gases started. The flow was kept up from 7 a. m. to 4 p. m., while during the night the casing was taken off the beam to permit free access of atmospheric air. In most cases the test was continued thus through three consecutive days. Afterward, the concrete below the steel was chipped off to lay bare the steel and show whether rusting had occurred.

It should be remarked that preliminary tests had showed the adopted gas mixture to be an effective corroding agent. Tests with CO_2 and water vapor gave no rusting, but with oxygen

*These tests were part of a series of beam tests made for the Expanded Metal & Corrugated Bar Co., of St. Louis, Mo.

TABLE I.

	Material.	7-day test. No. of tests.	7-day test. Strength in lbs. per sq. in. Max.	Min.	Average.	28-day test. No of tests.	28-day test. Strength in lbs. per sq. in. Max.	Min.	Average.
1898	Sand Key, Tortugas (medium)	12	252	188	215	11	327	237	290
1898	Garden Key, Tortugas (coarse and fine)	12	208	172	190	8	394	232	280
1898	Garden Key, Tortugas (fine)	8	173	155	167	8	281	236	256
1907	Key West (coarse)	6	300	230	251	6	303	275	277
1907	Snipe Point (fine)	11	201	155	173	11	283	195	241

added a steel bar would be completely covered with rust after 24 hours.

We have summarized the results in the following tabulation:

Beam No.	Age at Load Test, Days	Load in Load Test, Lbs.	Load in Rusting Test, Lbs.	Result.
20	144	9,900	10,900	No rusting observable.
21	145	13,200	13,100	"
22	141	9,900	10,900	"
23	144	13,200	13,100	"
24	146	9,900	10,900	"
25	146	9,900	10,900	"
26	147	9,900	10,900	"
27	147	9,900	10,900	"
28	146	9,900	10,900	"
29	146	9,900	10,900	"
30	146	9,900	10,900	"
31	147	9,900	10,900	"
32	147	9,900	10,900	"
33	147	13,200	13,100	"
34	142	16,550	13,100	Considerable rusting transverse to length at 3 wide cracks.
37	174	16,550	13,100	Rust along 2-3 ins. at horizontal adhesion crack; at another point rust ¾-in. long.
38	170	13,200	13,100	No rusting observable.
40	171	13,200	13,100	"
41	143	15,400	13,100	Slight rusting at crack.
42*	156	9,900	10,900	No rusting observable.
43	141	9,900	13,100	"
44	154	13,200	10,900	"
45	155	13,200	13,100	Slight rusting at cracks.
46	154	13,200	13,100	No rusting observable.
47	181	16,500	13,100	Slight rusting at cracks.
48	180	13,200	13,100	No rusting observable.
51	102	13,200	13,100	"
52	102	13,200	13,100	"
53*	117	9,900	10,900	"
54	114	13,200	13,100	"
Three other beams			6,600	"

*Exposed in rusting test during 14 days; all other beams 3 days.

The cement was of the Rüdersdorf brand. Its composition was stated by the manufacturers to be as follows: Silica, 21.86%; alumina and iron oxide, 10.3%; lime, 62.5%; magnesia, 1.67%; sulphuric acid, 1.69%. Its loss on ignition was found to be 1.32%. Its specific gravity, as received, was 3.145.

TESTS ON RUSTING OF STEEL RODS EMBEDDED IN CONCRETE.

In 1905, Mr. J. M. Braxton, U. S. Assistant Engineer at Key West, Fla., prepared four blocks of coral sand and broken brick concrete, in each of which was embedded a ½-in. steel rod and putting two in about 4 ft. of water in the ocean and two in a dry closet in the testing laboratory, left them for some weeks over a year. At the end of that time the blocks were broken and the rods examined for rust. It was found that the rod in one of the blocks which had remained in the dry closet showed signs of rusting but that the other three rods were as bright and smooth as when they were placed in the blocks. The test was on so few specimens, however, that Mr. Braxton decided the next year to make more extensive tests. The results of these latter he has just reported to the U. S. Engineer officer in charge of fortification works on the east coast of Florida. They are abstracted below.

The blocks tested were 12 × 12 × 6 ins. in size, made under usual working conditions of one part Portland cement, three parts sand and five parts broken brick. Embedded in the center of each block was a ⅝-in. diam. twisted steel rod 8 ins. long. Fifteen sets of two blocks each were made, ten with the coral sand, or disintegrated coral rock, common to the beaches of the Florida coast and five with ordinary silica sand. Of the ten coral sand blocks, five were with brick crushed to pass through a 1-in. ring and five through a 2-in. ring; all of the silica sand blocks were made with 1-in. crushed brick aggregate. Some of the rods were dipped in either a fresh or salt water grout before being embedded in the block and some were put into the concrete clean and dry. Of every set half of the blocks were placed in the ocean after a 24-hour set and half were kept in the air without roof protection. After 1 year and 21 days the blocks were all broken and the rods examined for evidences of rust with the results as shown in the table.

It will be noted that all blocks allowed to remain in sea water show no signs of rusting in the rods but that all those allowed to set in the air show some rusting regardless of the make-up of the concrete, although the smaller aggregate silica sand and fresh water seem to be a nearly perfect protection.

We are indebted to Mr. Braxton for this information and for the results of the tests.

COST OF HAULING A WATER MAIN ACROSS CHANNEL AT VANCOUVER, B. C.

The water supply of the city of Vancouver, B. C., is taken from behind a dam on the Capilano River some six miles north of the city and is from there carried to a reservoir just outside the city in a main which crosses the Burrard Inlet (on which the city is situated) in a series of 12-in. cast-iron pipes on the inlet bottom.

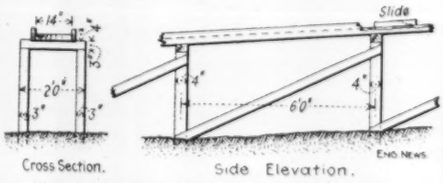


Fig. 1. Chute Used in Setting Up Pipe.

This inlet is over 1,200 ft. wide and from 65 to 75 ft. deep at its deepest part, with a strong current, and the size of the waterway together with the heavy traffic which it carried and which could not be obstructed, has made extremely difficult the placing of each of the seven mains which have been put in service within the last 19 years. The methods of placing the last main in 1906, together with the costs of the work, were very thoroughly described in a paper by Mr. John Causley before the meeting of the Canadian Society of Civil Engineers on Feb. 20, 1908. We give below a portion of this paper:

There have been seven 12-in. mains placed across the narrows at various times during the past 19 years. The last one has just been put in position, and of the method of accomplishing this the writer purposes giving a short description, trusting that it may prove of some interest, for the reason that it differed from the method usually followed in such work, viz., that of building a staging, or anchoring a string of rafts along the line to be followed, slinging the pipes over the position they are intended to occupy, jointing them up and lowering the connected line into place.

This method would not have been suitable in the cases under consideration on account of the water varying from 66 ft. deep at low tide to 75 ft. at ordinary high tide. The tide is very strong, running at speeds up to 8 knots per hour; also, and perhaps the most important of all, nearly the whole of the shipping trade of Vancouver, including ocean passenger and freight steamers, from 8,000 tons downwards, sailing ships towed in and out by tugs, coast steamers, rafts, coal barges, transfers towed by tugs, etc., passes through these Narrows. The system herein described of hauling the pipes across was first put into practice by the Water-Works Company, this system being greatly improved by the late City Engineer, Colonel Tracy, M. Can. Soc. C. E., and the water-works staff.

The first two mains were hauled across the Narrows by the Vancouver Water-Works Co., the rest of the mains being hauled by the Corporation of the City of Vancouver, which bought out the Vancouver Water-Works Co. in 1892.

About three years ago it was intended to place another main across the Narrows, and in the early part of 1904 a contract was made for the supply of cast-iron pipes for a submerged main, in accordance with the following specifications:

To be 12 ins. in diameter internally, 1 in. in thickness, lengths to lay 12 ft. each, of the best cast iron, strong, tough grey metal, cast vertically with the hub end down, the bell end to be bored spherically, and the spigot end to be turned where it fits in contact with the bored surface. To be tested to a pressure of 500 lbs. per sq. in. and hammered under pressure. To be coated with a bitulithic solution.

The pipes were obtained from Stavely, near Glasgow, in Scotland, and weighed between 1,725 and 1,800 lbs. each. The half section at a flexible joint shows the latest form of the bell and spigot of a pipe. The shape of the bell has been altered from that of the earlier forms to cause the pipes to offer as little resistance as possible in sliding along the bed of the inlet.

The pipes were then jointed on one shore for their entire length and, resting on an inclined chute, were hauled across the strait by cables attached as described hereinafter. The shape of the bell and spigot, shown in Fig. 3, constitutes a sort of ball-and-socket joint which permitted of the movement necessary to make the curve so that the pipe would conform to the inlet bottom. The hauling device is described as follows:

A chute was constructed of 2 × 14-in. dressed plank, with 1 × 4-in. battens on each side projecting 2 ins. above the plank and supported every 6 ft. by cross pieces of 3 × 4-in. quartering, each on two 3 × 4-in. posts (see Fig. 1), from low water on the north side of the Narrows extending back the length of the main. Each length of pipe was tested separately under a pressure of 350 lbs. per sq. in. The pipes were then placed on the chute, spigot ends to the south, with a piece of plank, about 2 ft. long, on the bed of the chute running between the side battens under each pipe at the bell end. The piece of plank was notched out at the top side and upper end, so as to go under, support, and steady the bell, and keep the pipe in the center of the chute. The under sides of these blocks were well greased. The spigot of each pipe was pressed home in the bell of the next one, lead run in and caulked to make a tight joint. No gaskets were used, as the bells and spigots were bored and turned to make tight and flexible joints. Each joint required from 60 to 70 lbs. of lead, making about 3½ tons of lead used in all. The pipes, after being put together and jointed, were tested collectively under a pressure of 150 lbs. per sq. in.

A line was pushed through the pipes with a rod made of a number of long slats of wood nailed together and a 1¾-in. steel wire cable hauled through them.

Over the lower, or south, end of the string of pipes a cast-iron cap 1-in thick, with strengthening ridges on the outer side, and flange overlapping the end of the pipe, was placed, leaded, and caulked. This cap had a 2-in. circular hole in the center with a stuffing-box. Through this was passed a 2-in. turned rod 3 ft. 6 ins. long, and the hemp packing was well tightened up around it. On the inner end of the rod was an eye through which the end of the 1¾-in. steel wire cable, which went through the line of pipes, was passed, doubled back on the cable, and secured with four clips.

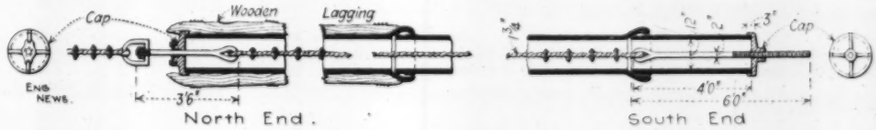


FIG. 2. METHOD OF ATTACHING CABLE TO PIPE.

TABLE SHOWING CONDITION OF REINFORCEMENT AFTER ONE YEAR.

(Tests at Key West, Florida.)

		Coral Sand				Silica sand	
		1-in. Brick.		2-in. Brick		1-in. Brick	
Mixed with.	Grout on rods.	In air.	In ocean.	In air.	In ocean.	In air.	In ocean.
Salt water	None.	Rusty, 75% surface brown	Perfect	Rusted full length one side. Pitted	Perfect	.....	Perfect
"	Salt water	Slightly rusty one end	Perfect	Rusted full length Pitted	Perfect	75% brown slightly pitted	Perfect
"	Fresh water	Four small rust spots	Perfect	Discolored one end. Nearly perfect.	Perfect	Brown one side.	.....
Fresh water	None	Rusted slightly for ⅓ length	Perfect	Seven spots about 1 in. sq. each	Perfect	Nearly perfect	Perfect
"	Fresh water	Nearly perfect	Perfect	Five spots about 1 in. sq. each	Perfect	Nearly perfect	Perfect

The outer end of the eye-bar, on which a screw thread was cut, went through a stirrup-shaped ring and was made fast to it with two nuts. To this stirrup one of the hauling cables was attached and secured in the same manner as the cable inside the pipes was secured to the other end of the bar. By these means the cable had no tension on the front end of the string of pipes. (Fig. 2).

The end length of pipe carrying the cap, etc., was covered with a wooden lagging, bound at three places with ⅝-in. wire rope. The sketch readily explains the arrangements made.

The cable on the west side of the pipes was attached to the fortieth pipe by taking two turns round the pipe, bringing the end back to the cable, and fastening it with four clips. The cable on the east side of the pipes was secured to the thirteenth pipe by means of a chain, which had a round turn round the pipe, and the ends made fast to the cable with clips. Iron bands were put round the pipe and cables fastened at intervals to enable a fair pull to be taken.

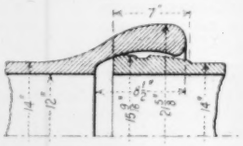


Fig. 3. Section Through Pipe Joint; Vancouver Water Main.

On the upper, or north, end of the pipe a cap similar to the one at the south end was placed, with the exception that the 2-in. circular hole in the center was through a plain boss. A 2-in. round bar passed through this hole. The inner end of this bar had an eye to which the cable through the pipes was attached, in the same way as the other end of the cable was fastened to the bar through the cap at the south end of the pipes. On the outer end of this bar a screw thread was cut, and the cable through the pipes was tightened up with a nut. A second nut was placed above the first one for the sake of security. A length of 12-in. pipe, 4 ft. long, was fitted into the bell of the last pipe for the flange of the cap to fit on to. The whole was leaded and thoroughly calked.

It had taken about a month to do this work, with a gang of about seven men. There were 109 12-in. pipes, making 1,308 ft. of pipes, whose weight varied from 1,725 lbs. to 1,800 lbs. each, giving a total weight of about 96 tons. Including lead caps, internal cable, etc., the total weight would be about 102½ tons.

Fresh steel-wire cables, 1½-in. and 1¼-in. in diameter, had been bought in Nanaimo, a coal mining town across the Gulf of Georgia. These cables were not new, but had been used for hoisting in the mines. Also four new 6-in. (circumference) 120 fathom manila ropes had been purchased, at $160 each, for tackle. Six new 3-sheave blocks and two new single-sheave blocks had been made in the water-works shops. The cables, on their reels, had been taken across to the north shore of the Narrows.

The end of a line was taken across, attached to the end of one of the cables, and the cable was hauled across, a snatch block and four horses being used. No power tackle was used, as the hauling had to be done in the space of about 15 minutes at slack water.

One cable was hauled across at slack water on Aug. 15, one on the 18th and one on the 19th. By Aug. 23, everything was ready to begin hauling. The cables had been examined by the diver and tightened up with their blocks and tackles.

To each of two of the cables was attached a tackle consisting of a pair of 3-sheave blocks with one of the 120-fathom 6-in. manila ropes rove through them worked by a capstan to each tackle driven by one or two horses. The other cable had two tackles, with a pair of 3-sheave blocks attached to each tackle, each tackle worked by a capstan. The drum of the capstan was 18 ins. in diameter, and the lever arms 11 ft. each. The cable, however, with the two tackles attached, had been left taut too long; the flood tide caught it and carried it up channel about 100 ft. at the center, drawing two lengths of pipe slightly out of line before it could be loosened. It was necessary to draw it back to the north side and haul it across afresh. This had been done by Aug. 25, and everything found to be in order. Passing vessels had caused some inconvenience when getting the lines across.

Hauling was started on Aug. 27 and proceeded, during favorable wind and tide, for a period of from two to five hours per day until Sept. 3, when the whole length of 1,224 ft. was finally placed in its correct position. Considerable difficulty was experienced with breaking capstans and sheaves, but these mishaps did not seriously retard the work. After the submarine pipe had been laid there was 84 ft. of pipe to be laid and leaded above low water to the valve chambers, bringing the total pipe length up to 1,308 ft. The main was tested on Sept. 5, and found to be perfectly tight under a pressure of 125 lbs. per sq. in.

In the accompanying itemized statement of costs, ordinary labor was paid from 25 to 30 cts. per hour, with half as much again added for extra time. The diver was paid at a rate of $15 per day. In the labor costs are included the costs of a man and team at $10 per day. The new cables bought cost $930, but the original cost account from which our data are taken does not plainly state to just what item they are charged. As, however, there is an incidental account of $469.94 in the materials for plant in placing the submarine portion, we have assumed that a part of the cost of cables has been charged in that item, leaving the remainder for the value of the cables at the end of the work. With this change and some other changes in arrangement the accompanying table is the same as in the original article.

COSTS OF HAULING WATER MAIN ACROSS INLET AT VANCOUVER, B. C.

Cost of Pipes—		
109 lengths 12-in. pipe @ 12-ft. = 1,308 ft. Total wgt. = 192,112 lbs. = 96.05 tons @ $40 per ton.	$3,842.00	
Removing to north shore of inlet.	200.00	
Total cost of pipe		$4,042.00
Cost of Placing Submarine Portion—		
Labor:		
July 2—Aug. 11, building chute and platform, capstans, placing and joining up pipes, etc.	$1,002.69	
Aug. 25—Sept. 8, hauling the main	1,163.23	
Total labor	$2,165.92	
Lead	$431.93	
Lumber for chute, 8,040 ft. at $18 per M.	144.72	
3 kegs nails	12.00	
2,436 ft. lumber for platform at $17 per M.	41.41	
New cables and incidentals	469.94	
Total materials and incidentals.	$1,100.00	
Total cost of placing submarine portion		3,265.92
Cost of Placing 84 ft. of Main Above Water—		
Labor		662.28
Cost of Taking of Old Main—		
Labor	$1,652.77	
Material and incidentals	403.59	
Total for old main		2,056.36
Grand total cost of operation		$10,026.56

BUILDING OPERATIONS IN 1907 in the United States show a decrease over those of 1906 but an increase over all previous records, according to a recently issued report of the U. S. Geological Survey. The total cost of the buildings erected in the principal cities of the United States in 1907 was $661,076,286, a net decrease of $17,634,683 or 2.6% from the figures of 1906, but an increase of 2.55% over those for 1905 and 40.86% over 1904. The unit cost of building, however, increased in the past year for there were some 184,055 permits issued in 1907 as against 181,174 in 1906. In the cities showing a decrease in building, New York takes the lead with a falling-off of $41,591,982 or 26.84%; St. Louis is next with $8,045,526 or 26.87%; Chicago next with $5,616,245 or 8.68% and Brooklyn last with only $149,304 or 0.21%, a better showing than in any of the large cities where normal conditions prevailed. The period of rebuilding in Baltimore has reached its height for a decrease was noted during the past year, although the exact figures are not now available.

Naturally, San Francisco leads the list in the increased building operation statistics. The total number of building permits issued in San Francisco during 1907 was 12,126, for buildings to cost $91,502,240, an increase of 162% over the building in 1906. In 1905, before the fire, the cost of building operations was only $18,268,753. Cambridge, Mass., and Cleveland, Ohio, also show an increase in building, due in the former to several large mercantile house constructions and in the latter to normal growth. In Cleveland the increase was 22.47% or a money value of $2,915,433.

Of the permits issued 60.88% were for wooden structures and 39.12% for fire-resisting buildings, but the cost of the latter amounts to 72.67% of the total.

HYDROGRAPHIC SURVEYS OF STREAMS in South Dakota were begun on May 4, 1908. It is proposed to make a complete survey of each stream in the State, including topographic location of irrigation districts and reservoirs. It is probable that the U. S. Geological Survey will eventually cooperate in the work. If it does, a profile of each stream surveyed will be made and gagings will be taken. The first field party, in charge of Mr. F. C. Huffman, Assistant State Engineer, is at work on Rapid Creek, midway between the Cheyenne River and Rapid City. Mr. Samuel H. Lea, M. Am. Soc. C. E., of Pierre, S. D., is State Engineer.

THE PANORAMIC CAMERA APPLIED TO PHOTO-TOPOGRAPHIC WORK.*

By CHARLES WILL WRIGHT,† M. Am. Inst. Min. E.

The application of the camera as an adjunct to topographic mapping began practically with its invention, and it has been employed with varying success since that time. With the exception of the camera described, the plate-camera has been universally used in this work, thus giving a projection of the photographed on a flat surface. From such photographs, by the rules of geometry and perspective, points defining topographic features and from at least two camera-stations may be projected upon a ground-plane—the map.‡

In 1904 I employed the plate-camera for the purpose in Alaska, but found that the labor necessary to plot the maps, even in a general way, was long and tedious. In 1905 a small Eastman panoramic camera was fitted with spirit-levels, a sight-alidade and a parent scale, introduced inside the camera to register the degree-points in the sky-line of the film, and also, arrows to indicate the horizon-line. This was, on the whole, successful; but the details in the topography were not brought out in the views with sufficient clearness, and the photographs were too small. These difficulties were overcome by obtaining a larger and more carefully constructed instrument, which was satisfactorily employed in the field during the year 1907.

A panoramic view is made up of an integral number of perspective views upon flat surfaces, and logically is the most accurate and direct means to obtain an impression of a field of view for purposes of mapping. In the perspective view, only one line—the vertical center-line—records the direct azimuth or bearing of

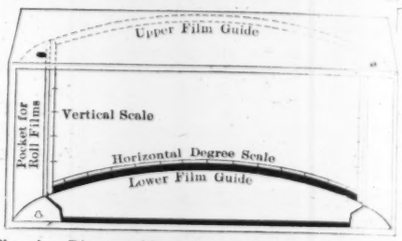


Fig. 1. Diagram Showing Positions of Horizontal and Vertical Scales in Camera.

points within its perspective; and all other points must be determined by geometric projection, thus introducing an element of error. In the panoramic view, where the negative is everywhere equidistant from the camera lens and in its focal plane, the positions of all points are in direct horizontal angular relation to one another on the negative, as in nature; and by introducing a degree-scale which, at the time of exposure, is photographed in the sky-line of the negative, the bearing of any point relative to any other point within the view may be read from it directly.

The underlying principles of this method, therefore, do not differ essentially from those used in plane-table surveying. In all cases it is necessary either to have two points within the area to be mapped, between which the horizontal distance has been determined; or, better, to have a preliminary triangulation of a number of the prominent points or peaks within the area which will form the base for the map, so that these determined triangulation-points may form tie-points for the camera-stations. It is then possible within certain areas to do the greater portion of the mapping with the aid of the camera alone. As in plane-table work, the traversing of trails and wagon-roads, and the determination of topographic stations, are more accurately made by an instrumental survey.

THE CAMERA.—The camera best adapted for this purpose at present on the market is the Al Vista camera, Model 5 B, which takes a 5 × 12-in. view, including an angle of 140° (Fig. 2). It consists of an oblong box, 6 × 6 × 11 ins., fitted with a lens of fixed focus, which may be made to revolve at different speeds within a half-circle, and with the introduction of apertures of various sizes allows the correct light-value for the exposure to be obtained. Retaining the film are two circular film-guides, so placed, one at the top and one at the bottom of the camera-box, that the film, in passing outside of them, will be in the focal plane of the lens at all points. For more exact work, a camera of this type should be constructed of metal, to eliminate the error which may be introduced by shrinkage of the wooden parts.

*Paper prescnted before Annual Meeting of American Institute of Mining Engineers, Toronto, July, 1907. Transactions Am. Inst. Min. E., No. 19, Jan., 1908.

†Ass't Geologist, U. S. Geological Survey, Washington, D. C.

‡Stanley, H. M. Photographic and Co-ordinate Surveying, Trans., Am. Inst. Min. E., xx., 740 to 766 (1891). Also, Fiemer, H. L. Photographic Methods and Instruments, Report U. S. Coast and Geodetic Survey, pt. 2, app. 10, pp. 619 to 735 (1897).

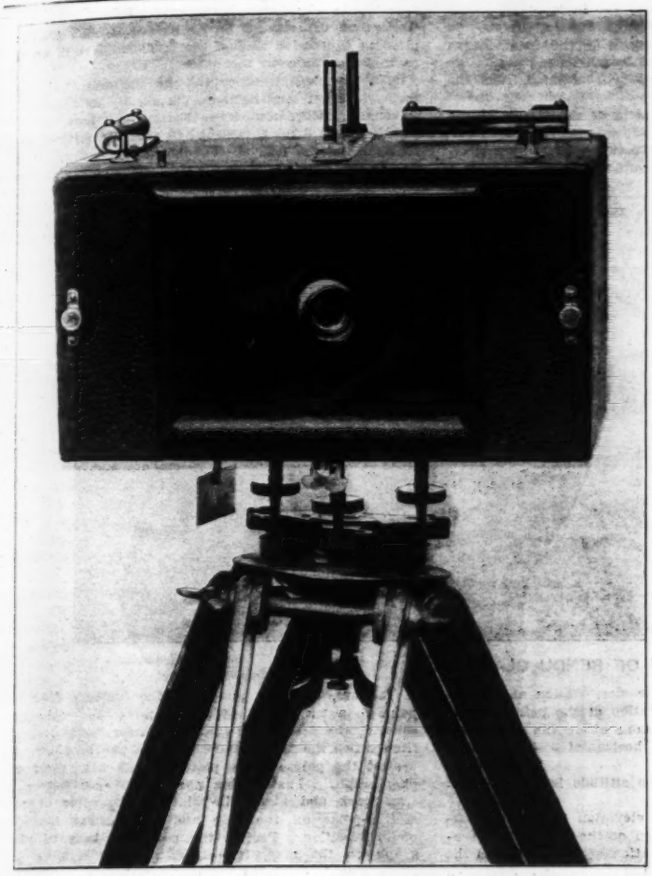


FIG. 2. PANORAMIC CAMERA FITTED FOR TOPOGRAPHIC MAPPING.

To fit the camera for surveying, both a horizontal and a vertical scale should be so adjusted within the camera-box as to be photographed on the sensitized film at the time of exposure. To accomplish this, a strip of metal or celluloid graduated into degrees ($1° = \frac{2\,r\,\pi}{360}$ when r = focal length of lens) is attached to the lower circular film-guide in such a way that the degree marks project ⅛ in. above the guide. The sensitized film passes on the outside of this, and when the exposure is made the degree-marks are photographed in the sky-line of the film. These degree-marks are nearly 0.1 in. apart on the negative; and on an enlargement of two diameters, angular readings may easily be estimated to an accuracy of 5′.

On the sides of the upper and lower film-guides is attached a thin metal strip, 0.25 in. wide, in which wedge-shaped notches are made, the divisions (= 1/20 in. for the camera used) being equal to a hundredth part of the focal length of the lens (see Figs. 1, 3 and 4). These two vertical scales must be adjusted so that the center-point marked on each strip will fall in the center of the camera-field or film, and a straight line connecting these two center points on the negative, after exposure, will thus establish the horizontal line. To the top of the camera-box two 60′′ levels at right angles to each other are adjusted and a sight alidade is attached, in such a manner that its direction of sight coincides with a line extended from the center of the lens to the zero or center-point of the horizontal scale inside the camera. The bottom of the camera-box is fitted with three leveling screws, adjustable to the transit-tripod. To make the camera more serviceable, and to eliminate the necessity of a transit at the camera-stations, a transit-plate with vernier may also be fitted to the camera-box; and from this all necessary angles can be read. From the photographs taken with a panoramic camera fitted with the above attachments it is possible to determine the positions, both horizontally and vertically, of all points within the area photographed.

ADJUSTMENT.—To determine whether the zero of the horizontal scale corresponds to the point of sight taken with the alidade, and also to ascertain whether the center-marks of the vertical scale representing the horizon-line are correctly placed, the procedure is as follows:

With the transit set up over a station from which a broad view may be obtained, sight on some prominent point and then take angular readings to other points and note several points of equal elevation to the station occupied. Set up the camera over this station, sight the attached alidade on the first point sighted with transit, and then take view. After development of the negative a comparison of the readings is made. If the zero of the horizontal scale does not fall directly over the point sighted with the alidade, shift the scale or alidade to the amount of difference indicated on the negative. If the points of equal elevation noted by the transit readings do not fall on the horizon-line represented on the vertical scales, it is a simple matter to adjust either the scales or the levels until such is the case. To make this latter adjustment perfect may require several trials.

A simpler way to adjust the vertical scales, and a test that should be made from time to time in the field, is to set up the camera on the shore-line of a lake or at sea-level and make an exposure; the horizon-line indicated by the vertical scales should coincide with the surrounding shore-line of the lake or the horizon-line of the sea. If this is not the case, the scales should be adjusted until harmony exists.

With the present camera adjustments for determining the parallelism of the film to the axis on which the lens revolves cannot be made. A camera, however, is under construction in which this and other adjustments will be possible.

FIELD-WORK.—The accuracy and detail of the mapping depend largely upon the precision of the base work, the number of camera-stations occupied, and also the scale of the map. If a careful primary and secondary triangulation of an area has been made, and numerous stations have been established, one could enter the field with camera alone and complete the field-work of a fairly accurate topographic survey of that section in the same manner one would use a plane-table, but in a much shorter time. With the plane-table, most of the plotting is done in the field, with the camera the same work is done in the office; with the plane-table one can occupy but one station at a time; with the camera, when plotting, one can practically occupy two or more stations at once and in this way simultaneously, from two or more points of view, see the area to be mapped. This latter circumstance is a strong factor in the identification of points. Again, when a mere reconnaissance-survey is to be made, the topographic work may be accomplished with the camera while the triangulation is advancing. By so doing, not only time is saved, but much information regarding the timber-limits and density of growth, and in some instances characteristics in land-sculpture and geologic structure, may afterwards be obtained from the photographs, all of which would be omitted by the usual method of mapping. For reconnaissance work the camera is, therefore, especially to be recommended.

All the triangulation-stations occupied by the transit, should also be occupied by the camera, thus securing a check on the triangulation. In selecting camera-stations, those taken at low and moderate elevations are of greatest service as aids in drawing the topographic details, while those at high elevations are best for advancing the triangulation. In each case, however, it is necessary to have three previously-determined points in the field of view, preferably at wide angles, which may be sighted with the alidade on the camera from the station occupied, so that, from the angular readings taken, the position of the camera-station can be determined. The elevations of these intermediate stations are noted from barometric readings and later are checked by determinations from the elevations of known points included upon the negative. The elevations of the triangulated points, where the transit is employed, are determined in the usual way by vertical angle-readings upon points of known elevation or at sea-level.

It is hardly necessary to mention the advisability of erecting monuments or signals upon all stations so that they may be sighted from other and new stations.

PLOTTING MAPS FROM PHOTOGRAPHS.—It is first necessary to develop the film-negatives—the best plan being to do so in the field, so that a defective negative may be replaced by taking another view at once. Such failures, however, are not probable. During the past summer I took 200 views under all conditions of weather, and not one of the negatives was defective. They were developed in the field, for the most part within a day or two after exposure; and several dozen, left undeveloped until my return to the office, some three months later, were developed with equally good results.

A preliminary plotting of triangulation-points, and camera-stations on the map should be done in the field, and traverses of trial and shore-lines should be added.

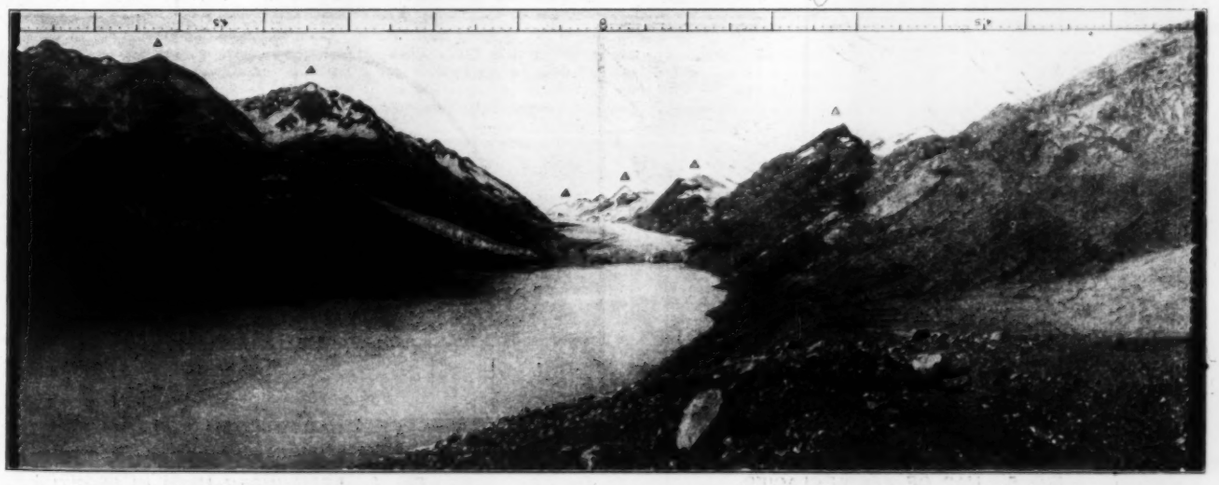


FIG. 3. VIEW OF RENDU GLACIER, GLACIER BAY, ALASKA, AS TAKEN BY PANORAMIC-TOPOGRAPHIC CAMERA.

This is recommended to prevent the introduction of "holes" in the map, that is, small areas which cannot be accurately plotted in the office, because they were sighted from but one station, or were otherwise neglected. In the office, to facilitate the topographic plotting, enlargements are made from the negatives, which were 5 × 12 ins., to prints, 10 × 24 ins. in size. As the horizontal and vertical scales are photographed on the negative at the time of exposure, no error is introduced by making these enlargements. The uneven contraction and expansion of photographic paper is often a cause of error in plotting; but if care is taken in developing and drying the prints, and if they are all made on the same kind of photographic paper, this error is only a slight one. To eliminate it, however, plotting may be done directly from the negatives.

Having established a map-scale and plotted the triangulation-points, the camera-stations should next be determined. This is done by the three-point method, by which the angular readings to three or more determined points, taken from the station, either by a transit or read from the photograph, are plotted on a piece of tracing-paper. The lines indicating the angular readings are placed over the respective points and the positions of the camera-stations thus located.

The camera-stations being plotted on the map, one may next proceed to select numerous points common to two or more views from different stations, and to plot their positions by lines of intersection representing their respective bearings read from the horizontal scale on the photograph.

To facilitate this work a T-square 1 ft. long is made, the vertical arm being divided to correspond with the vertical scale of the photograph. The photograph is adjusted to a drawing-board 12 × 24 ins. in size, so that the center-line of the vertical scales coincides with the center-division marked on the T-square. (Fig. 7.) On the map a line is drawn from the respective camera-station in the direction sighted at the time the photograph was taken, and by the aid of a protractor, and angular readings taken with the T-square from the horizontal scale, the directions of all points may be plotted. When the position of any point has been determined by the intersection of its lines of direction from two or more stations, its relative elevation may be obtained by multiplying the number of divisions on the T-square above or below the center-line by the horizontal distance of the point, measured in feet, and dividing by 100, as the divisions represent hundredths of the focal length for the photograph. (The focal length or radius for the enlarged panoramic photograph is obtained from the formula $r = \frac{2}{\pi} H$, where $H = \frac{1}{4}$ of the circumference of circle or distance measured between 90° on the horizontal scale of the enlarged photograph). This result is added to the elevation of the camera-station above sea-level and the sum is the elevation of the point. Thus, if a mountain-peak is 20 divisions above the center-line on the vertical scale and the horizontal distance measures 8,000 ft., then its relative altitude is $\frac{20 \times 8{,}000}{100} =$ 1,600 ft.; this added to the elevation of the camera-station gives the total elevation of the peak above sea-level. (In computing the elevation of distant points the correction for curvature of the earth and refraction should be added).

When plotting, the photographs showing the same area from two stations are set up on the drawing-table, as shown in Fig. 7, and points seen from both stations are numbered directly on the photographs, the same numbers being used to indicate the points on the map.

The protractor used in this work was of card-board, 10 ins. in diameter, with the central portion cut out. This was oriented on the map over the camera-station and made fast with thumb-tacks. A narrow scale, 10 ins. long, divided into units of the map-scale, and fitted with a pin-point at the 0 mark, served as a protractor-arm as well as a scale for measuring the horizontal distance. This arrangement is shown in Fig. 7.

To obviate the necessity of orienting the protractor for each station, and to facilitate plotting, an engineers' parallel movable protractor may be used to advantage. As this protractor has a fixed orientation it is necessary to determine the azimuth for the zero-point on each photograph and to adjust the horizontal scale so that the direct azimuth readings may be taken from the photographs.

After a sufficient number of characteristic points have been plotted upon the map and their elevations noted, it is a simple procedure to introduce the lines of contour by the aid of the photographs. By using above method an experienced topographic draftsman com- plete an expressive map of the land-sculpture in area from photographs in the office.

Both the plotting of points and the determination of their elevation may be done graphically as follows:

Construct a framework, consisting of 3 bars, equal in length (about 5 ins.), attached to a curved strip of metal sheeting, of the size of the photograph, shown in Fig. 6. At the junction of the 3 bars representing radii of the arc, attach a pin-point; the distance from pin-point to outer surface of curved metal sheet should be equal to the determined focal length for the photographs from which the map is to be plotted. On the photograph, project the points to be plotted to its base (bottom of photograph). Fasten this photograph face out to the framework and place pin-point on the same over the station-point on the map and then orient it in the photo direction. Project the points at base of photograph on the map, indicating them by numbers corresponding to those on the photograph. In this manner the direction of each point is plotted directly from the photographs.

To ascertain the altitude of points on the photograph relative to the camera-station we have this proportion: The measured distance, y, of point on photograph above or below the horizontal line is to the determined focal length for photograph, f, as the elevation of the point E above or below camera-station is to its horizontal distance, x, from the camera-station. This proportion, $y : f :: E : x$, gives $xy = Ef$, which is the formula for a hyperbola in which x and y are the variable and E and f the constant factors.

To construct the diagram, divide the horizontal axis of a rectangular co-ordinate system into units of the map-scale; from this, at points representing intervals of 1,000 ft. horizontal distance, erect vertical lines, on which the computed lengths of y for each 100 ft. elevation at the respective horizontal distances are indicated. By connecting the points which represent the same elevation on these vertical lines of the diagram, hyperbolic curves are formed (see Fig. 8), each curve representing points of equal elevation at their respective horizontal distances. With a diagram thus constructed, we can scale the horizontal distance of a point directly and also measure its elevation, relative to the camera-sta-

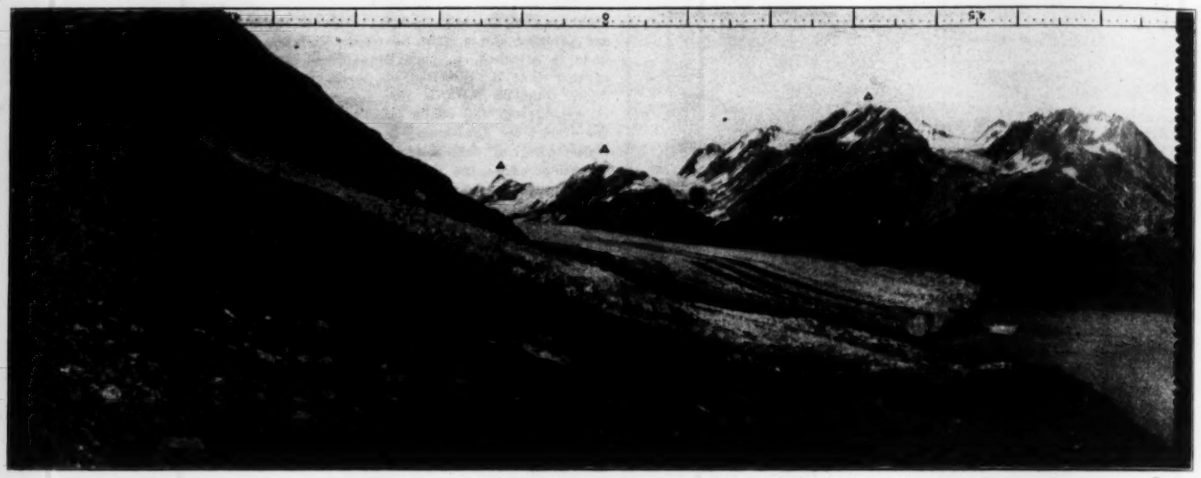


FIG. 4. ANOTHER VIEW OF RENDU GLACIER.

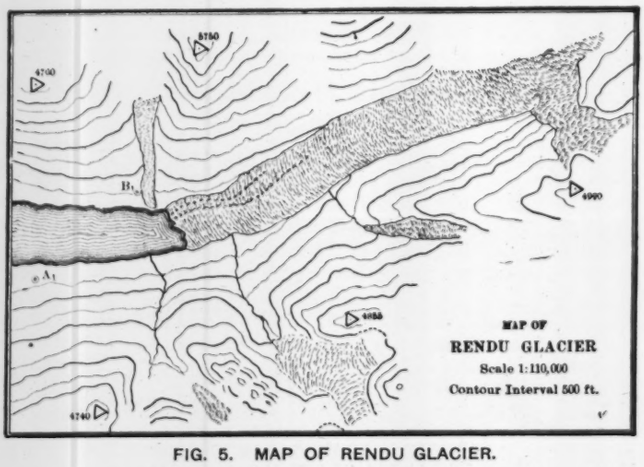


FIG. 5. MAP OF RENDU GLACIER.

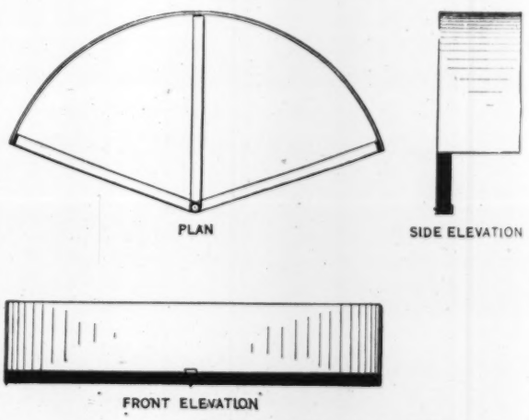


FIG. 6. FRAMEWORK USED IN PLOTTING.

tion, by transferring, preferably with a pair of dividers, the distance *y* from the photograph to the diagram, directly above the point indicating its horizontal distance. The practicability of this graphic method has not been tested, but, though it may lack in accuracy, it will undoubtedly facilitate and greatly shorten the work of plotting the maps.

ACCURACY OF METHOD.—The two photographs, Figs. 3 and 4, may serve to illustrate the panoramic method. These views are of Rendu Glacier, in Glacier Bay, Alaska. The peaks with a triangle over them are triangulation-points determined in 1892 by Professor H. F. Reid, whose map was used as a base. The two camera-stations occupied, on opposite sides of the inlet, were located by transit-readings on the triangulation-points. These points and stations were first plotted on the accompanying map, Fig. 5; the positions of numerous points represented on each photograph were determined by the above method, and a map sufficiently accurate for the intended purpose was thus constructed.

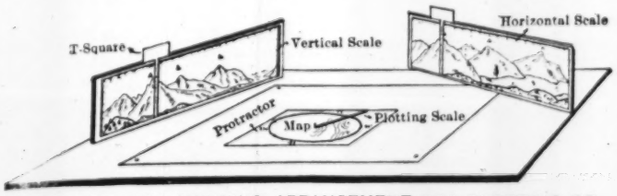


FIG. 7. SKETCH SHOWING ARRANGEMENT FOR PLOTTING OF MAP FROM PHOTOGRAPHS.

The maximum difference in elevation of a point measured on photographs from two or more camera-stations seldom exceeds 10 ft. for a horizontal distance of one mile. Determinations of the two triangulation-points shown in the accompanying views gave the following results:

Triangulation Pt. 1, from Sta. A. Horizontal dist. = 31,500 ft. Elevation = 4,934 ft.

Triangulation Pt. 1 from Sta. B. Horizontal dist. = 25,000 ft. Elevation = 4,906 ft.

A difference of 28 ft. in a distance of 5 miles.

Triangulation Pt. 2, from Sta. A. Horizontal dist. = 14,500 ft. Elevation = 4,868 ft.

Triangulation Pt. 2, from Sta. B. Horizontal dist. = 18,400 ft. Elevation = 4,842 ft.

A difference of 26 ft. in a distance of 3 miles.

ADVANTAGES OF THE PANORAMIC CAMERA METHOD.—Photography cannot replace instrumental topographic surveying, and, in many areas, cannot be used at all; yet experience has shown it to be a valuable adjunct in nearly all surveys. The topographic features of an area will necessarily determine the method to be employed in its mapping. A flat, rolling plain cannot be mapped in the same manner as a rugged mountainous region, or a heavily timbered area where broad views cannot be obtained. Areas of bold topography with sharp or often rounded summits and little timber, such as are encountered in the western states and Alaska, are most advantageously mapped by the camera method. To make a plane-table survey of such an area requires the expenditure of much time in the field in constructing the map, and the expense of a large field-party. The conditions of weather which exist along the western coast and in Alaska are such that the summits are enveloped in a cloud of fog, often during the greater portion of the day. When the view is clear for a short time only, a photograph of the surrounding country may be taken, thus completing in a fraction of an hour the work at a station which would require many hours or even days by the plane-table method. It should be noted that alidade-reading and note-taking from a mountain-top in Alaska on the usual cold, foggy day, with a still colder wind blowing, is by no means comfortable, and even the best topographers are inclined to hurry their work. In this manner, some portions of an area are more carefully mapped than others. Having the photographs of an area with the bearings of all points registered directly above them, the plotting of the map can be done with more agreeable surroundings in the office, where all conveniences are at hand, and thus a map can be constructed of more uniform accuracy, and with as much detail as desired. If this or a similar graphic method of mapping were applied in certain regions a great deal would be saved in both time and expense, compared with topographic surveying as generally practiced.

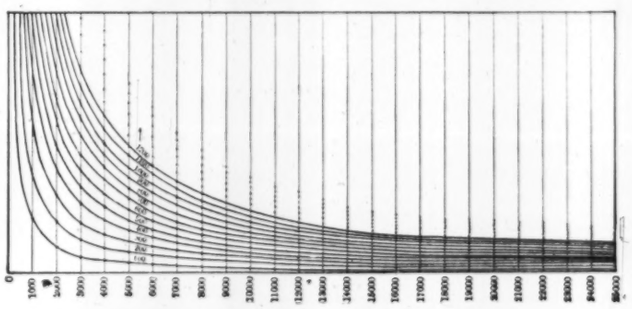


FIG. 8. HYPERBOLIC DIAGRAM FOR DETERMINING ELEVATION OF POINTS.

COMPARISON OF PANORAMIC CAMERA METHOD WITH OTHER PHOTOGRAPHIC METHODS.—In the present practice of photo-topography a photo-theodolite or similar instrument is employed. This consists of a specially prepared plate-camera with a fixed-focus lens adjusted to a horizontal transit-circle. Attached to the top of the camera-box is a telescope with vertical circle for the reading of vertical angles. At the back of the camera and directly in front of the sensitized plate are two cross-hairs, the one forming the vertical center-line and the other the horizon-line. Inside the camera is a flat magnetic needle attached to a disk, to which a vertical transparent scale is adjusted. This revolves directly in front of the sensitized plate so that when the exposure is made the magnetic bearing of the view is photographed upon it. With this instrument a group of eight views are necessary to complete a panorama, and the angular direction of each view must be read on the horizontal transit-plate and noted. Another disadvantage of the photo-theodolite is its weight and bulk, besides the limited number of plates which may be taken on a trip and the necessity of reloading the plate-holders. With the panoramic camera the daylight-loading films are used, which eliminate the danger of breakage, lessen the weight to be carried and permit development in the field directly after exposure, in a daylight developing-tank.

The plotting of a map from the views taken by the photo-theodolite is a long and tedious process (though possessing no special difficulties), and the office work necessary to complete the map is many times greater than that required for the same amount of mapping by the panoramic camera.

Since the publication of this article by the American Institute of Mining Engineers the writer has drawn up plans and specifications for the construction of a camera better adapted for this method of surveying. This instrument has been ordered through the Bausch and Lomb Optical Company. Both the camera and the method will be thoroughly tested in the field this summer by the U. S. Geological Survey and the accuracy of the method compared with that of plane table mapping. This new camera differs from the one described in that the scales and adjustments are of greater accuracy and the lens, levels, scales and alidade are all attached to an aluminum box of rigid construction. The back of the camera box is the only removable part, the other parts all being in rigid adjustment. These adjustments may be readily tested by removing the back of the camera and introducing a film roll with a focusing film attached (this latter is made by removing the sensitized portion of the film and matting the remaining celluloid sheet). By revolving the camera lens the photographic projection may be seen on this focusing film and at the same time the horizontal and vertical scales in the camera, and with a transit set up alongside of the camera at a point where a broad view may be obtained a comparison of the transit readings with those of the camera scales may be made directly in the field.

A COMBINED CONCRETE BARROW AND MIXER.

The Ransome Concrete Machinery Co. has recently put on the market a device which combines a concrete barrow and mixer so that it is possible to save the time and labor ordinarily needed in small work in the triple movement from storage pile to barrow, from barrow to mixer and from mixer back again to barrow. Fig. 1 shows the barrow, the usual concrete cart provided with interior blades for the more efficient mixing of the concrete, and the frame into which the barrow is placed to be revolved. Fig. 2 shows the cap cover clamped down on the barrow and the device ready for mixing concrete. The axles of the cart serve as axles of revolution, but the hubs act as journals, so that the wheels do not revolve in the mixing operation.

The mixer shown is hand driven, but they are also made so that they may be power driven, either in single or multiple parallel units.

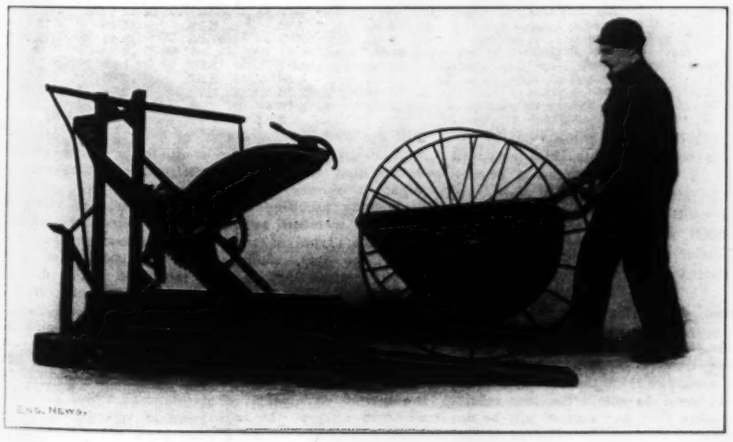


Fig. 1. Barrow on Way to Mixing Frame.

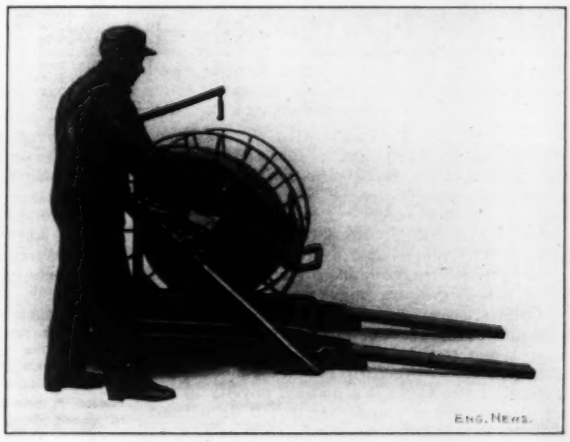


Fig. 2. Mixer in Operation.

COMBINED CONCRETE BARROW AND MIXER.
(Made by the Ransome Concrete Machinery Co.)

NEW RAIL SECTIONS AND RAIL SPECIFICATIONS OF THE AMERICAN RAILWAY ASSOCIATION.

The vexing question of securing better rails, including as an auxiliary the question of redesigning the present rail sections in order to improve the conditions of rolling by permitting lower finishing temperatures without injury to the thin flange of the base, was taken up by the American Railway Association something over a year ago. A strong committee was appointed to deal with the question. This committee

has called to its assistance a number of disinterested experts * * * [and] has also conducted a series of tests at the different rail mills in connection with its investigation of the discard and other problems.

The result of the year's work is a complete specification for Bessemer steel and open-hearth steel rails, and two series of new rail sections designed to remedy the unfavorable points of the present Am. Soc. C. E. sections (which are in wide use in this country). The new specifications and sections were submitted by the Committee to the Association at its last annual meeting, April 22, 1908, being proposed for adoption as "Recommended Practice" of the Association. They were so approved.

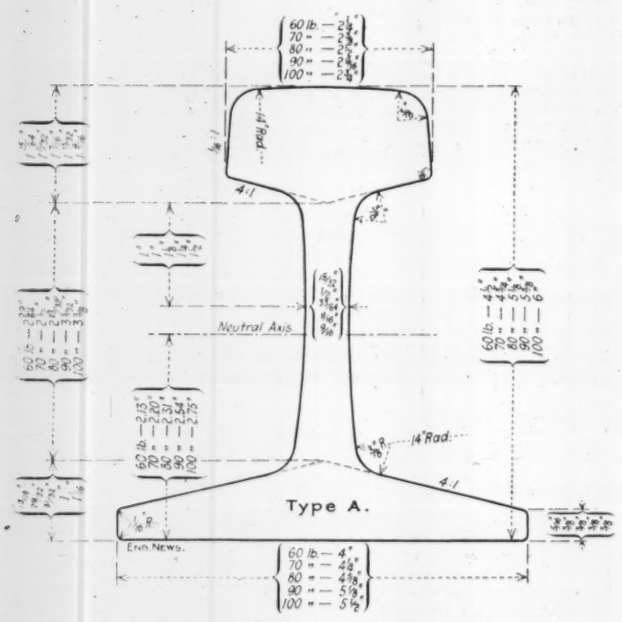


FIG. 1. NEW RAIL SECTIONS, TYPE A, AMERICAN RAILWAY ASSOCIATION, APRIL 22, 1908.

PROPERTIES OF RAIL SECTIONS—TYPE A.

	60-lb.	70-lb.	80-lb.	90-lb.	100-lb.
Sectional Areas, Sq. Ins.					
Head	2.21 (37.7 %)	2.68 (39.3 %)	3.05 (38.8 %)	3.20 (36.2 %)	3.64 (36.9 %)
Web	1.41 (24.1 %)	1.49 (21.8 %)	1.65 (21.0 %)	2.12 (24.0 %)	2.29 (23.4 %)
Base	2.24 (38.2 %)	2.65 (38.9 %)	3.16 (40.2 %)	3.50 (39.8 %)	3.91 (39.7 %)
Total area	5.86 (100%)	6.82 (100%)	7.86 (100%)	8.82 (100%)	9.84 (100%)
Moment of inertia	15.41	21.05	28.80	38.70	48.94
Section Modulus.					
Head	6.50	8.21	10.24	12.56	15.04
Base	7.24	9.51	12.46	15.23	17.78
Ratio of Periphery to Sectional Area.					
Head	2.35	2.12	1.93	1.90	1.80
Web	3.12	3.07	3.57	3.30	3.21
Base	3.48	3.20	2.52	2.63	3.29
Total	3.12	3.00	2.50	2.52	2.92

NEW RAIL SECTIONS.—The new rail sections are fully represented by the drawings Figs. 1 and 2 herewith, compiled from the report. Tables below the drawings give the sectional areas and other properties of the several weights as calculated by the Committee. There are two types, A and B, and for each a full set from 60 lbs. per yd. to 100 lbs. per yd. is detailed. This provision of two types is a distinct novelty in the field of rail section standards; it will be noticed that type B is slightly stockier than type A, i. e., is somewhat smaller for the same weight.

Almost equally novel is the elimination of all sizes between the even 10-lb. weights. This was advisedly done to keep down the number of different sections, although several railways make extensive use of rails of intermediate weight, as 85-lb. for first-class trackage. Indeed, the Committee was strongly urged to provide for the 85-lb. size in its list of standard sections, but after full consideration it refused to accede to the request.

We need not remind the reader that there has been a growing dissatisfaction with the American Society of Civil Engineers' list of rail sections, especially with the heaviest section, 100 lbs. per yd. The Society's Committee on Rails has been occupied with the question of revising these sections, in connection with its revision of rail specifications, but up to the present has progressed no farther than to draw up a set of guiding principles for the design of rail sections [Eng. News, Jan. 23, 1908, p. 105]. The Pennsylvania Railroad took a more definite step in 1907 by designing an 85-lb. and a 100-lb. section of improved distribution, and placing a trial order for rails of this section. This trial resulted a few months ago in the final approval of the new sections for the 1908 rails of the company. The Pennsylvania sections were shown in our issue of April 16, 1908, p. 427.

The American Railway Association's Committee reports on the subject of rail sections as follows:

The Committee, after considering the criticisms and suggestions received in reply to Circular No. 768, and after visiting the mills and witnessing the rolling of rails of both the new types of section, are confirmed in their opinion that a change from the Am. Soc. C. E. section is necessary in order to obtain the best results in manufacture, and while they feel that it will be desirable to unite on a single type as the standard of this Association, the views expressed by the various members in reply to Circular No. 768 indicate that it will be necessary to provide two types as originally suggested, at least for the present, and pending the time when both of these types can be tried out in actual service.

Some of the replies to Circular No. 768 indicate a fear on the part of certain members that the narrowing of the base proportionate to the heights made necessary to balance the section and secure the head at a lower temperature, would tend to reduce the stability of the rail and increase the cutting of the ties. These points were considered in designing the sections, and it was determined that so far as stability is concerned the sections are well within the limits of safety, and with respect to the cutting of the ties it was felt that the increasing wheel loads of modern traffic necessitate the use of tie plates on curves and soft wood ties in any event.

In considering the necessity for different weights of section, the Committee decided in the beginning that it would be sufficient for five different reasonable purposes to submit designs for five different weights, increasing from 60 to 100 lbs. per yd. by 10-lb. increments. The replies to Circular No. 768, however, indicated a desire on the part of a number of the large roads to re-

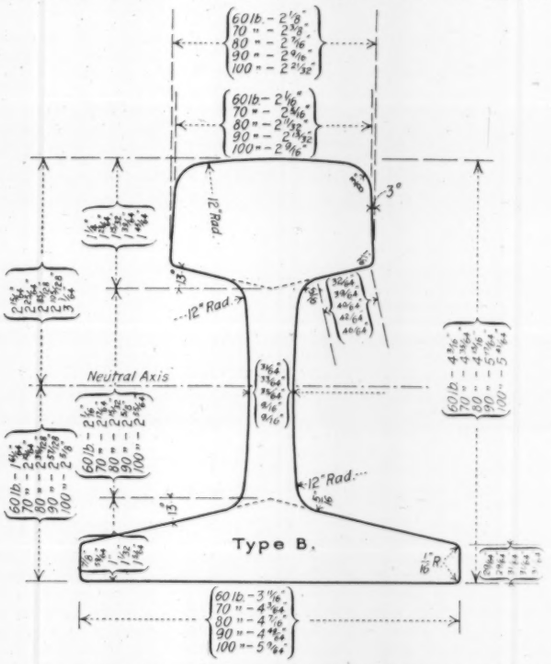


FIG. 2. NEW RAIL SECTIONS, TYPE B, AMERICAN RAILWAY ASSOCIATION, APRIL 22, 1908.

PROPERTIES OF RAIL SECTIONS—TYPE B.

	60-lb.	70-lb.	80-lb.	90-lb.	100-lb.
Sectional Areas, Sq. Ins.					
Head	2.28 (38.8 %)	2.76 (40.1 %)	3.07 (38.8 %)	3.56 (40.1 %)	3.95 (40.2 %)
Web	1.14 (19.4 %)	1.34 (19.5 %)	1.54 (19.5 %)	1.70 (19.2 %)	1.89 (19.2 %)
Base	2.45 (41.8 %)	2.79 (40.4 %)	3.30 (41.7 %)	3.61 (40.7 %)	4.01 (40.6 %)
Total area	5.87 (100%)	6.89 (100%)	7.91 (100%)	8.87 (100%)	9.85 (100%)
Moment of inertia	13.3	18.6	25.1	32.3	41.3
Section Modulus.					
Head	5.90	7.79	9.38	11.45	13.70
Base	6.80	8.62	11.08	13.21	15.74
Ratio of Periphery to Sectional Area.					
Head	2.10	1.90	1.79	1.68	1.64
Web	4.38	4.10	3.57	3.65	3.60
Base	2.94	2.76	2.72	2.58	2.49
Total	2.90	2.72	2.53	2.42	2.37

The Committee reports on the subject of rail sections as follows:

The Committee, after considering the criticisms and suggestions received in reply to Circular No. 768, and after visiting the mills and witnessing the rolling of rails of both the new types of section, are confirmed in their opinion that a change from the Am. Soc. C. E. section is necessary in order to obtain the best results in manufacture, and while they feel that it will be desirable to unite on a single type as the standard of this Association, the views expressed by the various members in reply to Circular No. 768 indicate that it will be necessary to provide two types as originally suggested, at least for the present, and pending the time when both of these types can be tried out in actual service.

Some of the replies to Circular No. 768 indicate a fear on the part of certain members that the narrowing of the base proportionate to the heights made necessary to balance the section and secure the head at a lower temperature, would tend to reduce the stability of the rail and increase the cutting of the ties. These points were considered in designing the sections, and it was determined that so far as stability is concerned the sections are well within the limits of safety, and with respect to the cutting of the ties it was felt that the increasing wheel loads of modern traffic necessitate the use of tie plates on curves and soft wood ties in any event.

In considering the necessity for different weights of section, the Committee decided in the beginning that it would be sufficient for five different reasonable purposes to submit designs for five different weights, increasing from 60 to 100 lbs. per yd. by 10-lb. increments. The replies to Circular No. 768, however, indicated a desire on the part of a number of the large roads to re-

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tain the 85-lb. standard now in quite general use, and such strong demands were made for a section of this weight that the Committee felt at one time that it might be necessary to yield on this point, and thus double the number of weights to meet the views of individual members as they had previously doubled the number of types of section for the same cause. Recently, however, some of the important lines have shown a disposition to drop the 85-lb. standard, and as the Committee has again been urgently importuned by the manufacturers to hold the railroads in line on this matter, in order to prevent the multiplication of sections which will surely result unless the Association takes a firm stand at this time, your Committee has determined to hold to its original recommendation in the matter of weights of section, and trusts that the members will see the importance of subordinating personal preferences to the general good. It is quite generally recognized that all reasonable demands can be met by the series of sections herewith submitted, and for roads now using an intermediate weight it will

surely is no great hardship to change, when it is considered that they have the option of going either higher or lower than their present standard.

The Committee feels that this is an opportune time for action which will tend to reduce the number of types of rail weights to the minimum, and that if such action is not taken now it will be increasingly difficult to accomplish anything along these lines in the future.

With regard to the relation of the rail to the wheel bearing surfaces, the Committee had the fullest information from both the mechanical and maintenance-of-way viewpoints as to results of experience under all conditions before designing the sections submitted, and while a few members still favor an increase in the top corner radius it is believed that the Association will be safe in following the recommendation of the Committee in this particular.

The Committee feels that the main objects of the investigation have been accomplished in the work already done, and that members are now in a position to secure the best rails which can be manufactured in the present state of the art. The adoption of the new and better balanced sections will enable the manufacturers to roll the rails at lower temperatures, thus ensuring a finer grain and better wearing quality, as well as reducing the internal stresses. The nearest approach to a single standard type has been arrived at consistent with present engineering knowledge and opinion. Provision has been made for the rejection of all rails containing dangerous physical defects, and means have been provided for keeping accurate records of the rails rolled from different parts of the ingot, and for uniform reports of rail failures, so that accurate information as to the cause of failure will be available in the future.

* * * The experiments with canted rails, referred to in the report of April, 1907, have not been carried on long enough to enable your Committee to arrive at any definite conclusion, but a recent inspection of these experimental rails indicates that the canting will cause a tendency to tighten up the gage, and it is also observed that on curves the metal of the top of the head "flows" to the inside of the low rail, instead of to the outside as in usual practice. This latter tendency will have to be reckoned with in considering the effect on flange wear.

RAIL SPECIFICATIONS.—Complete specifications were drawn up by the Committee for both Bessemer and open-hearth rails. The two are practically identical except in chemical requirements, and we have therefore consolidated them, indicating the several divergences.

Specifications for Bessemer and Open-Hearth Steel Rails.

Proposed by the Committee on Standard Rail and Wheel Sections and approved by the American Railway Association as Recommended Practice, April 22, 1908.

(NOTE.—The specifications for Bessemer and Open-Hearth are identical except for the chemical composition, and some clauses in paragraphs 10 and 13. Words in italics appear only in the Bessemer specification; words in brackets [ ] appear only in the open-hearth specification.—Ed)

The entire process of manufacture and testing shall be in accordance with the best current state of the art, and special care shall be taken to conform to the following instructions:

1. PROCESS OF MANUFACTURE.—(a) Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

(b) "Bled" ingots shall not be used. ("Bled ingot"—one from the interior of which the liquid steel has been permitted to escape.)

(c) There shall be sheared from the end of the bloom formed from the top of the ingot, sufficient "discard" to insure sound rails. (All metal from the top of the ingot, whether cut from the bloom or the rail, is the "top discard.")

2. CHEMICAL COMPOSITION.—The chemical composition of the steel from which the rails are rolled shall be within the limits shown in the accompanying table.

3. SHRINKAGE.—The number of passes and speed of train shall be so regulated that, on leaving the rolls at the final pass, the temperature of the rails will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100-lb. section, of 6½ ins., and ⅛ in. less for each 10 lbs. decrease of section. No artificial means of cooling the steel shall be used between the "leading" and "finishing" passes, nor after the rails leave the finishing rolls; neither shall rails be held before sawing for the purpose of reducing their temperature.

4. DROP TEST.—The drop testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of 5 ins.

The anvil block shall be adequately supported and shall weigh 20,000 lbs.

The supports shall be a part of or firmly secured to the anvil.

The test piece shall be placed head upward on solid supports, 5 ins. top radius, 3 ft. between centers, and subjected to impact tests, the tup falling free from the following heights:

60, 70 and 80-lb. rail	16 ft.
90-lb. rail	17 ft.
100-lb. rail	18 ft.

One drop test shall be made on a piece of rail rolled from the top of the ingot, not less than 4 ft. and not more than 6 ft. long, selected by the Inspector from each heat of steel.

(Special or additional tests may be made at the discretion of the Inspector.)

The temperature of the test pieces shall be between 32° and 100° F.

(a) If the test piece breaks without showing "pipe," or physical defect, all rails from that heat shall be rejected absolutely.

(b) If, however, the test piece broken shows "pipe," or physical defect, the top rail from each ingot of that heat shall be rejected, and

(c) A second test shall then be made of a test piece selected by the Inspector from a rail other than that from the top of the ingot. If this second piece breaks, the remainder of the rails of the heat shall also be rejected. If this second piece does not break, the remainder of the rails of the heat will be accepted.

If the test piece does not break under the drop test, it shall then be tested to destruction, and

(d) If, when so tested to destruction, the test piece shows "pipe," or physical defect, the top rail from each ingot shall be rejected; the remainder of the rails of the heat will be accepted.

(e) If, when so tested to destruction, the test piece does not show "pipe," or physical defect, all the rails of the heat will be accepted.

5. SECTION.—The section of rail shall conform to the template furnished by the purchaser as accurately as possible consistent with the paragraph relative to specified weight.

An excess of 1-32 in. in height of rails, and a variation of 1-16 in. in width of flange will be permitted, but no variations will be allowed in dimensions affecting the fit of the splice bars.

6. WEIGHT.—The weight of the rail shall be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in the contract.

A variation of one-half of one per cent. from the calculated weight of section, on an entire order, will be allowed.

Rails will be accepted and paid for according to actual weight.

7. LENGTH.—The standard length of rails shall be 33 ft. Ten per cent. of the entire order will be accepted in shorter lengths varying as follows: 30-ft., 28-ft., 26-ft. and 24-ft. A variation of ¼ in. from the specified length will be allowed.

All No. 1 rails less than 33 ft. long shall be painted green on both ends.

8. DRILLING.—Circular holes for splice bars shall be drilled in accordance with specifications of the purchaser. They shall in every respect conform accurately to drawing and dimensions furnished and must be free from burrs.

9. STRAIGHTENING.—Care must be taken in hot-straightening rails, and it must result in their being left in such condition that they shall not vary throughout their entire length more than 3 ins. from a straight line in any direction when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so marked. Rails while on the "hot" beds shall be protected from coming in contact with water or snow. The distance between supports of rails in the gagging press shall not be less than 42 ins.; supports to have flat surfaces. Rails shall be straight in line and surface and smooth on head when finished—final straightening being done while cold. They shall be sawed square at ends, variations to be not more than 1-32 in., and prior to shipment shall have the burr caused by the saw cutting removed and the ends made clean.

10. BRANDING.—[All open-hearth rails must be marked O. H. to distinguish them from Bessemer rails when in track.] The name of the maker, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. Rails to be lettered consecutively "A," "B," "C," etc., the rail from the top of the ingot being "A." In case of a top discard of twenty or more per cent., letter "A" will be omitted. All rails marked "A" shall be kept separate and be shipped in separate cars.

11. NO. 1 RAILS.—No. 1 rails shall be free from injurious defects and flaws of all kinds.

12. NO. 2 RAILS.—Rails which, by reason of surface imperfections, are not classed as No. 1 rails, shall be considered No. 2 rails, but No. 2 rails shall not be accepted for shipment which have flaws in the head of more than ⅛ in., or in the flange of more than ¼ in. in depth, and these shall not, in the judgment of the Inspector, be, in any individual rail, so numerous or of such a character as to render it unfit for recognized No. 2 rail uses.

Both ends of No. 2 rails shall be painted white, and shall have two prick punch marks on the side of the web near the end of the rail, so placed as not to be covered by the splice bars. They must be kept separate from No. 1 rails and be shipped in separate cars.

13. INSPECTION.—(a) Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

(b) The manufacturer shall, before the rails are shipped, furnish the Inspector *daily with carbon determinations for each heat, and a complete chemical analysis every 24 hours representing the average of the other elements contained in the steel for each day and night turn* [with a complete chemical determination for each heat]. These analyses shall be made on drillings taken from small test ingots. The drillings for analysis shall be taken from the ladle test ingot at a distance of ¼ in. beneath the surface.

(c) All tests and inspection shall be made at the place of manufacture prior to shipment, and so conducted as not to interfere unnecessarily with the operation of the mill. On request of the Inspector the manufacturer shall furnish drillings for check analysis.

BESSEMER STEEL RAILS.

	60-lb.	70-lb.	80-lb.	90-lb.	100-lb.
Carbon	0.37—0.47	0.40—0.50	0.43—0.53	0.45—0.55	0.46—0.56
Manganese	0.80—1.10	0.80—1.10	0.80—1.10	0.85—1.15	0.90—1.20
Silicon	0.10—0.20	0.10—0.20	0.10—0.20	0.10—0.20	0.10—0.20
Phosphorus—not to exceed	0.10	0.10	0.10	0.10	0.10
Sulphur—not to exceed	0.075	0.075	0.075	0.075	0.075

(When lower phosphorus can be secured, a proper proportionate increase in carbon should be made.)

[OPEN-HEARTH STEEL RAILS.

	60-lb.	70-lb.	80-lb.	90-lb.	100-lb.
Carbon	0.50—0.60	0.55—0.65	0.60—0.70	0.65—0.75	0.70—0.80
Manganese	0.75—1.00	0.75—1.00	0.75—1.00	0.75—1.00	0.75—1.00
Silicon	0.10—0.20	0.10—0.20	0.10—0.20	0.10—0.20	0.10—0.20
Phosphorus—not to exceed	0.04	0.04	0.04	0.04	0.04
Sulphur—not to exceed	0.06	0.06	0.06	0.06	0.06

(When higher phosphorus is used, a proper proportionate reduction in carbon should be made.)]

These specifications should be compared with the principal rail specifications worked out in the last few years by other organizations active in the question. Chief among these, besides the new Pennsylvania R. R. specification [Eng. News, April 16, 1908, p. 427], are (1) the specification of the American Railway Engineering & Maintenance-of-Way Association of 1904 [Eng. News, March 24, 1904, p. 275]; (2) that adopted last summer by the American Society for Testing Materials [Eng. News, July 4, 1907, p. 9], and (3) that promulgated by a committee of the American Society of Civil Engineers at the annual meeting of January 15, 1908 [Eng. News, Jan. 23, 1908, p. 105].

It is gratifying to observe that the American Railway Association's specification embodies the most progressive or highest requirements of these other drafts, and in particular departs most widely from the Am. Soc. T. M. specification, which, as we noted in our reports of that society's meetings and discussed editorially in our issue of July 4, 1907, p. 18, represented an abandonment of a number of important fighting points in the struggle for better rails. In fact, the present specification meets practically all the extreme demands that were urged in vain before the American Society for Testing Materials. The only exception to this is the clause governing discard; and here the Committee adopts the ingenious expedient of the Pennsylvania R. R. specification, also contained in the Am. Ry. Eng. & M. of W. 1904 specification, of requiring, instead of a specific amount of discard, "sufficient discard to insure sound rails."

The effect of this clause is greatly reinforced by the drop-test clause identical with the corresponding P. R. R. clause [but not found in the Am. Ry. Eng. & M. of W. specification], which rejects part or all of the heat when the top rail proves to be piped.

In many respects the specification follows more closely the Am. Ry. Eng. & M. of W. specification than either the Am. Soc. C. E. or the Am. Soc. T. M. But as the latter two are more recent than the first-named, by three years, it may be better to compare the new specification with them alone. Aside from the radical discard and piping clauses, there is a distinct novelty in the system provided for marking the rails according to their position in the ingot. The other clauses may be compared directly with those of the two specifications referred to.

Compared with the Am. Soc. C. E. specification (1908) the new specification requires a materially different chemical composition. For Bessemer rails, it calls for somewhat lower carbon, higher manganese, the same sulphur, the same silicon, and higher phosphorus; for open-hearth rails, it calls for higher carbon, higher manganese, the same sulphur, the same silicon and lower phosphorus. It agrees in requiring a drop-test from every heat, in limiting the camber to 3 ins. for No. 1 rails, and in fixing 33 ft. as the standard length of rail.

Compared with the Am. Soc. T. M. specification, the American Railway Association specification requires substantially the same carbon, same phosphorus, same silicon, and slightly higher manganese [the Am. Soc. T. M. specifies no sulphur limit]. A drop-test from every heat is required [against one from every fifth heat, of the Am. Soc. T. M.]. The camber is limited to 3 ins.

[in place of 5 ins.]. The shrinkage allowance is reduced. The standard length of rail is 33 ft. [against 30 ft. in the Am. Soc. T. M. specification].

The Committee's report contains an excellent statement of the reasons which determined its decision in various crucial questions, as reproduced by the following extracts:

With regard to the discard question, the Committee has always been of the opinion that it would be preferable to test the finished product rather than specify as to details of mill manufacture, and the Chairman, in his circular letter of May 27, 1907, addressed to the executive officers of the steel companies, stated that "The natural way for the railroads to overcome these difficulties would be to insist upon such tests—physical, chemical, and microscopical—as would result in giving them the kind of material they require for their purposes, and such as are universally required in the case of material for bridges, axles, etc." The difficulties which have stood in the way of applying this theory in connection with the manufacture of steel rails have been caused by the fact that rails are generally ordered in very large quantities and the product of a rail mill is turned out at a very rapid rate. A system of detailed tests which would answer in the case of axles and other material where the product is not so rapidly turned out would not be practicable in the case of rails because of the lack of time to complete the tests without curtailing the output of the plant. It was this difficulty which led to the adoption of specifications covering the details of mill practice, especially in connection with the discard.

In pursuing its investigation of this discard question, the Committee received a suggestion from Mr. William Metcalf to the effect that it would be reasonably practicable to apply the above theory to the manufacture of rails by arranging to test to destruction a number of rail butts representing a certain proportion of the total output, and to base rejections on the results of these tests. In order to determine the practicability of this suggestion, the Committee arranged for a trial lot of rails to be rolled from the ingot without any discard whatever except such as was necessary to enable the bloom to enter the rolls, and after these rails had been cut into small pieces, they were broken under the hammer and the fracture examined. This test proved to the satisfaction of the Committee that if "pipes" or other physical defects were present they could be detected by this means. The test also proved quite conclusively that it is possible to so conduct the process of manufacture that the "pipes" or other physical defects will be reduced to a minimum and that these defects may not occur at all, even in rails rolled from the top portion of the ingot.

In order to avoid an unnecessary waste of good material, the Committee set about to devise means by which the rejection of defective material could be insured without requiring an arbitrary and definite percentage of discard in every case, and a Committee of the Pennsylvania Railroad pursuing the same line of investigation, adopted a tentative specification which provided for a physical test of this nature, and which further provided that when physical defects were discovered, all top rails of the heat should be rejected. This would result in a discard of about 25% or 30% of the entire metal in the heat whenever physical defects were discovered, and it was felt that a requirement of this nature would not only provide for the rejection of defective material, but would insure the greatest care on the part of the manufacturer. A trial lot of rails was recently rolled under this specification as to discard, and the results convinced the Committee that a development of this idea would prove the best solution of the discard problem.

Some of the advocates of a fixed and arbitrary discard have argued that the mere provision of a discard to insure the elimination of "piped" rails, or rails containing physical defects, was not sufficient, and urged the rejection of a fixed percentage from the top of the ingot, because of the well-known fact that segregation occurs in the upper portion. This question of segregation was given careful consideration by the Committee, and while it is a fact that, due to the rearrangement of the constituent parts of the metal during the process of cooling and solidifying in the ingot mold, an analysis of the metal in the finished rail will often show a wide departure from the analysis required by the specifications, it is also true that an analysis of the metal taken from the different parts of the finished rail will frequently show similar wide variation. This discrepancy is due to the fact that the test ingot referred to in the specifications, and upon which the chemistry specification is based, is taken from the ladle before the metal is poured into the ingot mold, and consequently before the segregation takes place.

It has been assumed that, because of this variation from the standard composition of the metal in the finished rail, the rejection of all segregated metal would be warranted. But, on this assumption, it would be necessary to discard more than a third of the upper part of the ingot to be on the safe side, as the segregation frequently extends that far, and while our knowledge of the subject is not as complete as we could wish it to be, we have a great deal of evidence that rails of good physical condition can be made from the upper portion of the ingot. Furthermore, the analyses of a large number of rails taken after years of service indicate that these wide variations in chemical composition may occur without apparently affecting the safety or wearing quality of the rail, and since it is impossible to check the analysis of the finished rail with that of the test ingot, the question arises as to what limits should be placed on the variation which will be permissible. None of the experts consulted are ready to say what this limit should be, and all admit that no facts are available as the result of actual experience which would warrant the adoption of any fixed limit to govern the rejection of material. The provision in the new specifications for stamping the rails to show their position in the ingot will enable us to obtain more definite information on this point in the future.

The attention of the Committee has been called to the fact that certain railroads have been keeping this information for some years past and that the results show an excess of failures in the top rails. This information, however, is not conclusive for the purposes of the present investigation, for the reason that these rails were rolled under the old specifications as to discard, and we will be unable to determine definitely the effect of segregation until after we can observe the results of rails rolled under the new specification which will eliminate the rails containing physical defects.

In the matter of chemistry specifications for Bessemer steel rail, statistics were obtained from the officers of the Ore Producers' Association which convinced the Committee that it would be impossible for the mills to furnish more than a small percentage of the total rail requirements of the railroads with a phosphorus specification less than .10.

* * * It will be noted that no reference is made in the specifications submitted, to the deflection under drop test, as definite figures can only be inserted after the new sections have been actually rolled and tested. The Committee endeavored to obtain this information before submitting the specifications to the Association, but a sufficient tonnage of rails of the different weights of each of the new types has not been rolled as yet, and the tests already made indicate that it will be necessary to give the subject quite exhaustive study.

The committee which designed the new rail section and drew the specifications consisted of the following:

G. L. Peck, Genl. Mgr., Penna. Lines West of Pittsburg, Pa.
J. T. Richards, Chief Engr. of M. of W., Pennsylvania R. R.
F. A. Delano, President, Wabash R. R.
R. Montfort, Consulting Engr., Louisville & Nashville R. R.
Wm. Garstang, Supt. M. P., Cleveland, Cincinnati, Chicago & St. Louis R. R.
R. L. Ettenger, Consulting Mechanical Engr., Southern Ry.
W. E. Fowler, Master Car Builder, Canadian Pacific Ry.
P. H. Dudley, Inspecting Engr., New York Central Lines.
J. W. Kendrick, 2d Vice-Pres., Atchison, Topeka & Santa Fe Ry.

The final recommendation of the Committee's report is that the matter of collecting and studying the records of rails to be obtained by help of the specified system of marking for position in ingot be entrusted to the American Railway Engineering & Maintenance-of-Way Association. The same authority is to be asked to deal with the matter of developing the drop-test in such a way (if possible) as to make it approximate more nearly to the conditions of actual service, and is also to study the service results of rails rolled to the new forms of section, with a view to improving the details of the design if this is found to be necessary.

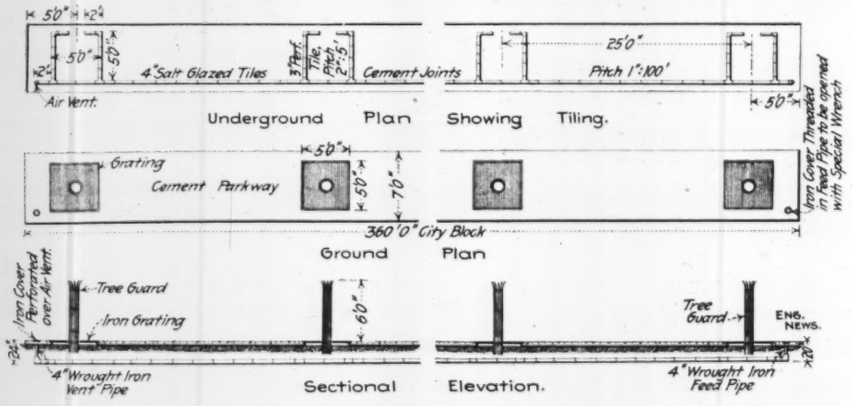

FIG. 1. UNDERGROUND PIPE IRRIGATION SYSTEM FOR TREES ON BOULEVARD, WEST CHICAGO PARK COMMISSION.

IRRIGATING TREES IN THE CHICAGO BOULEVARDS.

The supply of a sufficient amount of water to trees in paved streets is a problem in many cities. In order to ensure a proper supply of water to the trees along the West Side boulevards of Chicago a system of sub-irrigation has been devised and has already been applied for a distance of 1,300 ft. on Jackson Boulevard. The system is illustrated in the accompanying cuts. In each block is a line of 4-in. vitrified pipe with cement joints, and laid with a grade of 1-in. per 100 ft. At each tree there are two L-shaped branches of 3-in. perforated tile projecting on each side of the tree roots. At one end of the 4-in. main is a 4-in. iron vertical feed pipe, to which may be connected a hose from the nearest hydrant. At the other end is a similar pipe forming a vent. Fig. 1 shows plans and a longitudinal section. Fig. 2 is an enlarged cross-section at one of the branches.

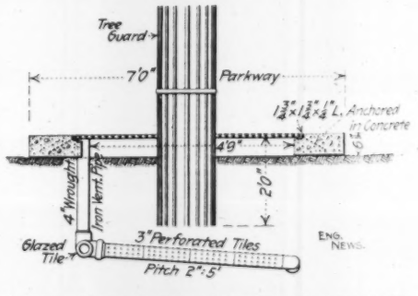

Fig. 2. Cross-Section Showing Perforated Tile Duct.

The system was planned by Mr. Jens Jensen, General Superintendent of the West Park Commission, Chicago; and has been carried out under the direction of Mr. A. C. Schrader, Chief Engineer of the Commission.

THE STANDARD LOCATION FOR THIRD RAIL CONductors adopted by the American Railway Association at its meeting on April 23 is described in a pamphlet prepared by the association and obtainable at its offices, 24 Park Place, New York City. The pamphlet shows both the top contact third rail systems as used on the Long Island R. R. and the West Jersey & Seashore R. R. and the under contact system as used on the New York Central & Hudson River R. R. A table shows allowable horizontal and vertical variations in rolling stock equipment.

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The American Railway Association's rail committee has produced an excellent piece of work in its new designs for rails and its rail specifications, reported elsewhere in this issue. The new rail sections, closely in agreement with various recent suggestions for improved rail shapes [the latest of them the Pennsylvania R. R. section shown in our issue of April 16, 1908] should enable the rail manufacturers to meet in full the demands for lower finishing temperatures and more thorough working in the rolls, two desiderata long recognized as necessary to the best results. A sacrifice of width of base has been made, but this unavoidable change is the least objectionable of all the reductions that could be made in the dimensions of the section. For while, as the Committee says, tie-cutting will undoubtedly be increased, under modern loadings tie-plates should be used on curves and over soft-wood ties in any event; and in the matter of stability the width provided is sufficient. The important thickening of the base is worth all it costs.

To meet the objection of those who might say that the Committee went too far, or not far enough, two sets of sections are available in the new designs, in one of which the process of condensation or thickening up has been carried farther than in the other. They appear to be the expression of divergent views in the Committee, and perhaps in the same degree will they satisfy the different opinions of rail users at large. But however useful it may be in this respect to have two sets of standard sections, the thing to be hoped for, of course, is the speedy elimination of one or the other type of section. There is no place for both. Either one or the other must prove to be best adapted to the complex exigencies of rail manufacture and rail service, and the recording and study of rail service which is to be carried on systematically in the future must first of all be a means for determining which of the two this is. It would be unfortunate if the Committee's wise restriction of the list of rail sections to the integral 10-lb. steps were to be permanently negatived by the continued existence of a double series of sections.

No less notable than the actual design of the new sections is the absence of all reference to increased weights of rail, or stronger varieties of steel. There was a good deal of talk a year ago, some of it from high sources, that the increasingly serious troubles of the steel rail could not be remedied except by the introduction of a much heavier rail, or else the use of a stronger steel, such as nickel-steel, or perhaps both. These claims were advanced in the face of the fact that the 100-lb. rail of recent years was proved by service records to be not only relatively but absolutely less reliable than the rail of lighter section, particularly the 85-lb. and 90-lb. rail. A great case was made of the statement that in the last twenty years the severity of service had increased much more than either the weight or the strength of the rail, primarily because of the rapid, constant increase in wheel-loads. But the Committee, after its careful study of the subject, has now tacitly but none the less emphatically rejected the demands for heavier rails or new kinds of steel; for its report does not even mention the desirability of looking toward either of these changes, even as a future contingency. This is in effect a clear approval of the 100-lb. rail for maximum service.

To bring this rail up to the proper level of quality, the Committee has done two things: First, specified such requirements of manufacture and tests as will, if properly enforced, ensure the acceptance of only such rails as have the necessary quality, and second, redesigned the rail sections so as to make it feasible to fulfil the spirit as well as the letter of these requirements. The rail sections, in the problem of securing better rails, are evidently only a means to the end. It is the specifications that express the end itself, more or less definitely. By putting open-hearth rails on the same footing as Bessemer; by fixing a drop test for every heat of steel; by taking this test from the top rail of the ingot, without retest unless physical flaws appear in the fracture, and even then rejecting all top rails; by reducing the allowable camber; and by providing a system which will permanently identify every rail as to its position in the ingot; the Committee has established requirements which not a long time ago were regarded as extremely radical. That so influential an authority as the American Railway Association has promulgated these requirements is particularly gratifying after the disappointing action of the American Society for Testing Materials, last summer, in adopting a rail specification in which every one of these progressive principles was abandoned. It may be said, of course, that the latter society represents equally the rail users, the manufacturers, and the independents, so that its specification, the joint work of all three parties, has the inestimable advantage of being non-partisan, while the American Railway Association represents the users exclusively. But we will hardly believe that the American Railway Association's Committee has neglected the practical viewpoint so grossly as to put out an impracticable or prohibitively expensive specification. The present specification has fully as great a claim for practical utility, on the score of the methods used in formulating it, as has that of the American Society for Testing Materials. It is for this reason that the great advance is a matter of gratification.

The way in which the matter of top discard is handled by the new specification may arouse much unfavorable criticism, and may even support a claim that the rails produced under it cannot be as good as those secured by earlier specifications. But we must recognize that the requirement of "sufficient discard to secure sound rails," coupled with the drop-test clauses, is fully able, under rigid inspection, to accomplish all that is wanted. And there is the important advantage that no greater burden is thrown on the manufacturer than the quality of his ingots actually justifies. If one steel-maker is so successful in pouring his ingots and controlling their cooling that he minimizes the extent of piping, shall he be penalized to cover the shortcomings of another whose ingots are not as good? Surely the specification as drawn is fairer.

The associated matter of segregation, which is so often spoken of as necessarily coexistent and coextensive with piping, also need give no cause for criticism. For we believe the view adopted by the Committee is quite sound. Segregation is erratic in its distribution, and by no means directly parallel to piping. More important, there is very little and only conflicting evidence as to the precise bearing of segregation effects on rail quality. Under the circumstances it cannot be said with assurance that a large fixed discard offers protection against injurious influence from segregation.

Readers of the new book on sewage disposal, noticed in our Engineering Literature Supplement this week, may well marvel at the number of things that had to be set right at several sewage purification plants built at Western army posts before the plants could be properly operated. Mr. Venable's experiences, however, are not so very surprising to those who have read some of the specifications for army-post sewage disposal plants sent out to bidders a few years ago—we hope they have been improved, of late, but cannot say. We refer particularly to absurd requirements as to bacterial purification demanded by the specifications, and the even more absurd and wholly inadequate contract-guarantee tests embodied in the specifications.

While it is gratifying to see a great government department recognizing the undesirability of polluting streams, it is, nevertheless, disappointing to see a department with which scores of engineers are connected send out specifications which go far towards demanding that sewage be turned into drinking water, and which specifications give no evidence of knowledge of the conditions governing the removal of bacteria from sewage nor of the tests required to determine whether or not the conditions established had been met. This is hardly the worst of it, however, for Mr. Venable's book indicates that the ordinary physical construction of these army-post sewage disposal plants was not properly carried out, through lack of engineering supervision or otherwise.

If steps have not yet been taken to reform such conditions as Mr. Venable notes, and as we observed several years ago in other government specifications, it would seem to be high time that the government availed itself of the services of some of the many American engineers who are now well versed in the design and construction of sewage disposal works.

The proposition now before the city authorities of Newark, N. J., to acquire all the drainage area above the Macopin intake of the famous riveted steel pipe lines of the Newark water supply has much to commend it. It is in line with what many British municipalities have practiced for years past, and with what a few American municipalities have done. In no other way can population be kept off a picturesque, salubrious and easily accessible water-supply drainage area. The Newark area has all these qualities, and particularly accessibility and popularity. Newark already owns a third of the 45 sq. mi. of this area, but its water supply is menaced by a number of growing villages; particularly Newfoundland, long a favorite summer resort. The acquisition of this land, if the expense be not too great, might prove much cheaper than the filtration of the supply. Eventually, filtration will be required, whether the city owns all the drainage area or not, but the large capital outlay and annual charges required for filtration might be postponed for many years if the drainage area were cleared of all habitation. There would, however, still be the railway traversing the drainage area, besides campers and trampers; and by-and-by a nicer regard for both the sanitary and the esthetic character of public water supplies will demand the purification of water from all surface sources, as is the case in Great Britain, and that, too, where the gathering grounds are practically uninhabited. These considerations should not deter Newark from extending its land ownership, for in that there is great safety, even when combined with filtration.

ASHES AS FUEL IN NEW YORK CITY.

Like a "stubborn unlaid ghost that breaks his magic chains at curfew time" the scheme of burning ashes will not stay down, but, in one guise or another, reappears to delude the credulous. A notable illustration of the way in which such a "will o' the wisp" may lead its followers from paths of reason into a morass of foolishness, is the fact that the Board of Education of the Borough of Manhattan, New York City, has been actually put on record in endorsement of the "ashes for fuel" scheme. It seems, from the available evidence, that during the past two years several janitors, and finally the Committee on Supplies, have conducted considerable research work in alchemy and with great success. This success is two fold (or two-edged) and is shown on one side by the official satisfaction of the above committee in being able to draw more B. T. U. from some source than were hidden there before. On the other side, if these modern alchemists could but see it, they have laid bare the lamentable incompetency and lack of practical ability in 70% of the janitors of the public schools of New York City.

To show the basis for such statements it is necessary to review only a few comparatively recent events. Late in 1907 an epoch-making document (to the minds of the promulgators) was sent out. It began thus:

DEPARTMENT OF EDUCATION.
The City of New York.

Special Instructions Relative to the Use of Waste Coal and Ashes, Moistened with a Solution of Oxalic Acid, Salt and Water.

To the Janitors, Engineers, Firemen, etc., of the Public Schools of the City of New York.

Dear Sir or Madam:

The Committee on Supplies, in conjunction with the Committee on Care of Buildings, has been experimenting with great success for almost a year with the solution above-mentioned, with a view of utilizing waste coal and ashes.

So as to find out if the janitors or others had been using the solution on their own account, a letter was sent to each requesting information regarding same.

Since that time more extended and complete experiments have been made, with the result that it has been determined by the representatives of the Committee on Supplies and the Committee on Care of Buildings that, not alone is it feasible to use in stoves, furnaces, low-pressure and high-pressure boilers waste coal and ashes moistened with a solution of oxalic acid, salt and water, but by the use of said solution a remarkable saving can be effected.

Because of these facts, you are hereby instructed to use all waste coal and ashes in so far as possible instead of putting it out in ash cans, and in doing so, observe strictly the following rules:

Among the "following rules" are a few worth recording.

PROPER SOLUTION.—Practical demonstrations have shown that the proper solution is composed of the following:

Hot water must be used in dissolving the acid and rock salt, because better results are obtainable. To every gallon of water necessary add two (2) ounces of oxalic acid and one (1) pound of rock salt.

HOW TO USE WASTE COAL AND ASHES, MOISTENED WITH SOLUTION, WITH VARIOUS SIZES OF COAL.—In schools where broken coal, or similar sizes, are used, ashes can be pulled to the door of the ash-pit, dampened with the solution and refired.

After you have used the ashes once, it may be reused again by moistening same with the solution.

After fires are cleaned in the morning enough coal should be put on to form a good body. When it becomes necessary to refire, moisten any waste coal or ashes you may have with the solution above mentioned. Of course, it will be necessary to make as many gallons of the solution as may be required to moisten the waste coal and ashes you may have on hand or that you contemplate using. Care must be taken not to saturate the mixture, as it mars its efficiency. A sprinkling can should be used when moistening the waste coal and ashes, as it is the best means of spreading the solution evenly. When it becomes necessary to refire, spread the mixture evenly over the entire surface to the extent of about 1½ to 2 ins. Should the fire become low during the day, a fresh body of coal can be formed over the mixture, after you have pushed the slice bar under it. Fresh coal should be used in the last covering for the day, so that when banking for the night with the mixture, a sufficient body of fire will be left after cleaning to start the next morning. By observing this rule strictly, you will save at least two coverings a day in firing. At the same time, you can generate steam much more quickly under the new method than with the old.

SAVING EFFECTED.—The Committee on Supplies and the Committee on Care of Buildings have reached the conclusion that the saving should be not less than 25% and should reach as high as 70%.

DISCRETIONARY POWER OF JANITORS, ENGINEERS, FIREMEN, ETC.—If any person should devise a better method than the foregoing, he is at liberty to send same to the Superintendent of School Supplies or Supervisor of Janitors, who will look carefully into the matter. On the other hand, if any janitor, engineer or fireman is not able to use the waste coal and ashes, moistened with the solution mentioned and produce the results anticipated, he must not experiment, but notify the Supervisor of Janitors or Superintendent of School Supplies, who will see to it that a competent person is sent to give instructions. The process is so simple there ought to be no difficulty in producing the desired result, but, as before stated, if you find any difficulty in using the solution do not experiment but send a notification, as instructed, and a person will be sent to show you how results may be obtained.

SPECIAL NOTE.—Engineers, janitors, firemen and others in care of stoves, furnaces, low-pressure and high-pressure boilers are hereby notified that comparisons will be made of the saving in each school and a record kept in the Bureau of Supplies and in the office of the Supervisor of Janitors, and such records will be taken into consideration when promotions are being made. All might as well realize that the Committee on Supplies and the Committee on Care of Buildings are convinced that money can be saved by this method with your cooperation. We, however, do not want to save money in coal and waste it in repairs to boilers and connections. Do not waste your time writing letters criticizing the matter but carry out the instructions set forth, because the formula has been tested and found satisfactory and feasible. Such being the case, you are expected to cooperate with the Department, because it will be to your advantage to do so.

A. J. Maguire,
(Supervisor of Janitors.)
Patrick Jones,
(Superintendent of School Supplies.)

Approved:
Thomas J. Higgins,
(Chairman Committee on Care of Buildings.)
Nicholas J. Barrett,
(Chairman Committee on Supplies.)

This surprising document was soon supplemented by another one in which use of the "big stick" was disclosed for all the laggards and indifferent ones. We reprint this in part:

Office of the Supervisor of Janitors.
DEPARTMENT OF EDUCATION,
Park Avenue and Fifty-ninth Street,
Borough of Manhattan.
January 29, 1908.

To the Janitors of Public Schools.

Dear Sir or Madam:

The Committee on Care of Buildings received a communication from the Committee on Supplies, under date of Jan. 16, relative to the use of oxalic acid and rock salt solution referred to in the circular sent out Dec. 12, 1907.

The result of these investigations shows that 70% of the janitors report a saving of from 15% to 50%, according to the conditions in their schools. The report further shows that some janitors have displayed and are displaying indifference and unwillingness to cooperate with the Department and the Committee on Care of Buildings and desires to call to the attention of every janitor that this indifference and unwillingness will not be tolerated.

The janitors who have cooperated with the Department and made it a success (and they are in the majority) are hereby commended for such cooperation.

Those who have not been able to use the solution, because of lack of oxalic acid and rock salt, are notified to do so immediately upon receipt of said supplies.

There is not a janitor in the system who cannot effect a saving of at least 10%.

The Committee on Care of Buildings desires to notify every janitor that the instructions contained in the circular were sent after a most careful investigation and report by competent men, and janitors who have not made a success with the solution are hereby notified that any further indifference or unwillingness to aid the Committee on Supplies in the matter of the saving of coal, will be sufficient reason for preferring charges against them.

Very truly yours,
Andrew J. Maguire,
(Supervisor of Janitors.)

Approved:
Thomas J. Higgins.
(Chairman, Committee on Care of Buildings.)

In at least one school, where there was a considerable mechanical plant and where the engineers and firemen were probably as competent as anywhere in New York, the first communication was received with some amusement which turned to astonishment at the second letter—the ultimatum. Yet these employees, willing to see if it could be true that a committee of politicians had at last succeeded in getting something for nothing, gave the magic fluid a trial on their ashes. The natural result followed. The fires were banked, their fuel beds were made solid masses of clinker, much unburned coal was held in the clinker and still more was wasted in building clean fires to be glutted with these anointed ashes. These negative results were reported with a request for the "competent persons" to show the proper methods of using ashes as fuel and to make a boiler test to determine the real economy of the scheme. The "competent persons" came, but in spite of their alleged ability they were found to be ignorant as to what constituted a boiler test, and they were not even able to make the fires burn. After clinkering up the fuel beds and putting out the fires these oxalic-acid experts left in bewilderment or disgust, and from then to now the fires under these particular boilers have burned evenly and economically and unmolested by the Committee of the Board of Education.

This committee has officially stated that 70% of the janitors have made a saving of 15% to 50% in their coal consumption. Casual observation of a few of the 70% brings out some interesting actions, shows how the saving may have resulted and points a way to even greater savings and true economy, without any attempt to use ashes as fuel.

First the dirty fuel bed is cleaned out as well as may be done with slice bar and hook, great chunks of clinker being pulled out of the fire door. Then a roaring fire is built up to get a fair bed of coals. A quantity of ashes are raked out of the ash-doors onto the firing floor where they are duly squirted with the magic solution. They are now spread as a blanket over the hot coals, cutting down the effective draft and deadening the fire. When the steam pressure is sufficiently reduced the process is repeated.

The ashes thus fired on top of good fuel form a sintered mass of clinker which can be lifted by one corner like a slab. This cellular slab then serves as a damper and these firemen are doing all too crudely only what they should do in regulating draft with flue or stack dampers. Their previous methods of firing must have allowed such a waste of heat up the flue and such an abnormal amount of coal in the ash that even the use of the crudest damper of ashes with all its seeming absurdities results in an appreciable saving of the coal pile.

The obvious moral of the whole incident is that the Board of Education or some of its committees stand in sore need of instructions as to the true relation between modern scientific knowledge and industry.

It is a chief object of education to enable a man to distinguish truth from error. Ignorance and credulity go hand in hand. The educated man ought to be able to distinguish and appraise at his true value the charlatan in politics, in theology, in law, in business and in industry. To be consistent, the Board of Education, when it officially adopted the plan of using ashes as fuel should at the same time have discarded all text-books on physics and chemistry, and substituted in their place lectures by leading promoters of perpetual motion machines and treatises on alchemy and the transmutation of metals.

LETTERS TO THE EDITOR.

Canadian and American Deep Waterways.

Sir: Referring to your editorials of Jan. 23, Feb. 6 and March 5, 1908, regarding the Erie Canal and possible Canadian competition by way of the proposed $75,000,000 deep waterway, from Georgian Bay to Montreal through Lake Nipissing and Ottawa River, I beg to invite attention to the treaty of Washington of 1871, which appears to govern the reciprocal relations of the two countries in waterways of common concern. Articles 26 and 27 of this treaty are as follows:

ARTICLE XXVI.

The navigation of the River St. Lawrence, ascending and descending, from the forty-fifth parallel of north latitude, where it ceases to form the boundary between

the two countries, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain, or of the Dominion of Canada, not inconsistent with such privilege of free navigation.

The navigation of the Rivers Yukon, Porcupine and Stikine ascending and descending, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the subjects to Her Britannic Majesty and to the citizens of the United States, subject to any laws and regulations of either country within its own territory not inconsistent with such privilege of free navigation.

ARTICLE XXVII.

The Government of Her Britannic Majesty engages to urge upon the Government of the Dominion of Canada to secure to the citizens of the United States the use of the Welland, St. Lawrence and other canals in the Dominion on terms of equality with the inhabitants of the Dominion; and the Government of the United States engages that the subjects of Her Britannic Majesty shall enjoy the use of the St. Clair Flats' Canal on terms of equality with the inhabitants of the United States, and further engages to urge upon the State Governments to secure to the subjects of Her Britannic Majesty the use of the several State canals connected with navigation of the lakes or rivers traversed by or contiguous to the boundary-line between the Possessions of the High Contracting Parties, on terms of equality with the inhabitants of the United States.

There may be a question as to whether this treaty controls in regard to canals built subsequent to its date, but it seems clear, in view of the specific statements of the treaty regarding the Rivers St. Lawrence, Yukon, Porcupine and Stikine, and the specific omission of Ottawa River—which at the time of the treaty was a navigable and navigated stream—that Great Britain and the Dominion of Canada would have a right to prohibit the navigation of Ottawa River by any but their own vessels, and similarly with regard to Lake Nipissing, or to prescribe tolls discriminating against American vessels on these waters.

While the British and Canadian governments would thus seem to have the power so to act regarding these waterways, they might not wish to do so from motives of policy. But if they should wish to do so, they might make it decidedly unpleasant commercially for United States shipping interests on the Great Lakes, should this projected Lake Nipissing-Ottawa River waterway be completed by the Canadian government.

It is possible that some later treaties may have so modified conditions in this respect as to make such course on the part of Great Britain and Canada impossible. It is hoped that this is so—but if it is I have no knowledge regarding it. It would certainly seem to be a matter worthy of consideration, when deciding as to the dimensions of such a canal as the new Erie, or of the Lakes to the Gulf waterway from Chicago to New Orleans.

Very respectfully,

C. F. Riché,
Major, Corps of Engineers.

United States Engineer Office, Rock Island, Ill., May 2, 1908.

The Future Policy of the Cameron Septic Tank Co. in View of the Final Decision in the Saratoga Springs Case.

Sir: In view of the far-reaching effect of the recent decision of the Supreme Court of the United States, declining to interfere with the decision of the United States Circuit Court of Appeals, sustaining the process claims of the Cameron patent in our suit against Saratoga Springs, et al., the enclosed statement briefly outlining the policy of this company in connection therewith, may be of interest to your readers:

The Cameron Septic Tank Co., desiring to comply with the wishes of its many clients, offers the following alternatives:

(1) To design sewage disposal plants and take contracts for complete construction.

(2) To furnish plans and specifications, and license the use of plants constructed thereunder.

(3) To license the construction and use of plants designed by other engineers.

Before the validity of the Cameron patent had been established by the courts, the Cameron Septic Tank Co. refrained from any interference with the operation of unlicensed plants, but now that this patent has been so completely sustained by the recent action of the Supreme Court of the United States, the same respect and consideration will be expected for it as has been accorded by the highest court. An invitation is therefore extended to municipalities and others owning infringing plants, to communicate with the Cameron Septic Tank Company for the purpose of effecting settlements, which may be secured on very reasonable terms provided useless litigation is avoided.

Yours very truly,
Cameron Septic Tank Company,
H. W. Wyllie, General Manager.

Monadnock Block, Chicago, Ill., May 9, 1908.

Friction Allowance in Tests Made With the Phoenix Testing Machine

Sir: Referring to the publication of Appendix 15 of the Quebec Bridge Commission's report in your issue of April 23: The amount of correction to be made to the failure loads of the columns on account of the friction of the testing-machine is taken at such a surprisingly high value that it would seem that this would bear investigation, and, I hope for the interest of the readers, that you will publish some information regarding this. It is especially hard to understand why there should be an allowance of 17½% for friction in compression tests and none whatever in tension tests.

The tests on columns published by Mr. J. A. L. Waddell in your issue of Jan. 16, 1908, were made on the Phoenix machine; no mention was made of any correction on account of friction of machine. Can you state if this correction was made, or if the results as published should be reduced for such correction?

Yours very truly,
A. W. Carpenter.

New York City, April 28, 1908.

[As stated by Prof. Burr in his report, the Phoenix machine was calibrated in 1897 in preparation for tests of cast-iron columns by the Department of Buildings of New York. A steel column of Phoenix section, 75.3 sq. ins. area, was built as a test-bar for this calibration; this test-bar was loaded first at Watertown and then at Phoenixville in both cases far below the elastic limit. The compressions on a marked length being measured, a comparison of the two furnished the data for calibrating the Phoenix machine in terms of the Watertown machine. The measurements are recorded in Engineering News of Jan. 13, 1898, pp. 27-29, where is given the correction factor 15.4%, deduced by the Department. Our own independent analysis of the data, also given, indicated a slightly higher correction. This calibration was made for compression tests only.

The subject was raised again, but for tension tests, in 1904, when we presented a series of results of eyebar tests from the Phoenix machine. An inquiry based on a letter from Mr. G. C. Henning elicited a letter from Mr. John Sterling Deans, which was printed in our issue of Feb. 23, 1905, p. 205. Mr. Deans there says, speaking of *tension* tests,

> It was found that with a pressure averaging 3 lbs. per sq. in. the piston of the machine could be forced through its entire stroke. The area of the piston being 3,000 sq. ins., the force necessary was therefore 3,000 lbs. The elastic limit of the smallest eyebar in question involved a pull on the machine of 660,000 lbs. The friction therefore was less than 1½% of this amount. This 9,000 lbs. total friction would apply to all tensile tests on the machine.

The Phoenix testing machine was described, with drawings, in our issue of Jan. 10, 1891, p. 42. The cylinder is 64.1 ins. in diameter, and the piston has a gland packing. There are four 8½-in. piston rods, which pass through stuffing-boxes in the front head. Thus the pressure area for tension tests is 3,000 sq. ins., while for compression tests the area is 3,227 sq. ins.

The column tests made for Mr. Waddell do not, so far as we know, include any deduction for friction.

Prof. A. Martens, of the Berlin Testing Laboratory, has recently discussed rather briefly the subject of cup-leather friction in hydraulic testing-machines. He concluded from his tests and his experience (most of the European hydraulic machines are equipped with weighing levers at the tail-block and thus do not rely on the hydraulic gage readings) that the friction of a cup-leather packing is a practically constant precentage of the loads, and when once determined the correction may be applied to all subsequent gage-readings with assurance that no error greater than about 1% will be involved. He further suggests that a friction allowance of 5% deducted from the gage values will ordinarily suffice. This is very far below the error of 17½, or even 15%, charged against the Phoenix machine. However, the latter does not employ cup-leather packings.

It seems highly important that new determinations of the friction of the Phoenix machine should be made, in order to establish with reasonable confidence the true value of its readings. Such determinations would need to cover a sufficiently wide range as to be independent of two opposed but equally arbitrary assumptions: (1) that the friction is a constant amount irrespective of load, and (2) that the friction is a constant percentage of the load. In the test of Model Chord No. 1 in connection with the Quebec Bridge Inquiry, Prof. Burr argued on the side of safety in applying to the load of some 2¼ million pounds the full percentage of error determined ten years ago for loads only one-fourth as large.—Ed.].

The Corps of Engineers and Our Public Works.

Sir: The discussion growing out of your editorial of January 30, concerning the engineering administration of the Public Works of this country is interesting to those of us who as Civilian Engineers are engaged in these works.

I believe it cannot be regarded as in any way probable that the Corps of Engineers of the Army will be wholly dispossessed of a responsibility which it has borne honestly, or relieved of a duty which it has performed creditably. When it can be shown that the Corps as a body of civil engineers is not trustworthy, the time will then be ripe for retiring its members to strictly military duties. No charge of inefficiency or of dishonesty rests against the Corps as a whole, and neither charge could be successfully sustained.

It should be clearly understood that the Corps of Engineers, their civil assistants, and *graduates* from these two bodies, form the aggregate of engineers who are specialists in River and Harbor works. *Graduates* are men who have left the service of the Engineer Department after an ample term of service. These three groups hold the bulk of the men trained and experienced in work of this class, and therefore competent to design and execute it intelligently and successfully.

The present demand is for *more* specialists in River and Harbor Engineering not *fewer*, and the solution of this problem by deducting the ranking men of the present administration is bad arithmetic, illogical and unbusinesslike.

In the days of fable, when the head of the Hydra was cut off, two heads grew out where but one existed before, but this process of multiplication by decapitation is not recognized in modern business methods. You cannot cut off the head of an Engineer Officer and have two equally competent heads pop up to replace him.

All this discussion comes as part of the reform wave which is sweeping over the country. Everything must be held in the focus of the lime light, and dissected. It is a good thing, and if the present organization were right in all details, the light would reveal only the strength. But it is not all good, and needed reorganization and adjustment may come from putting it under the analytical rays.

Since the engineering material—the trained specialists available to handle the Public Works—are in the three classes mentioned above, members of the Corps, civil assistants, and *graduates*, it will be well to touch briefly on each.

There is only one way of entrance to the Corps of Engineers and that is by graduation from the Military Academy at West Point. The men of highest standing in each class choose as a rule assignments to the Corps of Engineers. Thus, the Engineers are picked men, the cream of the West Point graduates. After graduation the Lieutenant of Engineers takes two or three years of post-graduate work in schools of application in which older Engineer Officers and Civilians are detailed as instructors. The fact that the young Engineer Officer does not do a part at least of his post-graduate work in some of our Civil Engineering schools of high standing may be a vital defect in his professional training. If so, the government might establish at Cornell or the Massachusetts Institute of Technology, or the University of Michigan, a professorship in River and Harbor work—and for the rest let the lieutenant work out his Master's degree in Civil Engineering. However, the lieutenant really gets his practical training as understudy to a Major or a Colonel—on works in progress. As he gains years, experience and rank, he has charge of work of increasing importance—until finally a point is reached where the best details—the most important engineering works—are for the best men. A capable Major may have charge of work more important than that assigned to an easy-going Colonel. In the end, the highest distinction is the position of Chief of Engineers—appointed by the President from among the Colonels.

Now, one thing in the career of an Officer of Engineers needs noting and emphasizing. Aside from his novitiate as understudy, the Engineer Officer is always *Chief Engineer* on the works under his jurisdiction; and his training must fit him under the existing system to be an *executive*. He can hire technical assistants, but he must be master, he must have charge of the office, disburse the money, and direct the clerical, technical and labor departments.

If a man makes the Engineers at West Point, carries himself with reasonable propriety, and has some application, he is pretty sure to perform the functions of a *Chief Engineer* most of his life—until he is retired at 64 on three-quarters pay.

It is well known that the pay of Engineer Officers is inadequate and wholly out of proportion to the magnitude and importance of the works they administer and the organizations they direct.

A Lieutenant-Colonel in charge of construction work aggregating nearly sixteen million dollars, with over three hundred employees under him, is paid less than $5,000 a year. In civil practice the chief engineer in charge of such great works would receive $10,000 a year or more.

It is not to be wondered at that some of the best men of the Corps, like Symons, Gillette and Sewell, have been drawn into civil practice with its more adequate pay. These are some of the *graduates*; and this is one of the ways in which the Corps tends to become depleted.

Under the present conditions the ability of the Corps to expand in numbers to an extent that will furnish competent civil engineers to meet the expansion of our Public Works may be doubtful. On account of the indifferent pay of Officers, West Point is not so attractive to ambitious and able young men as it was 25 years ago. That the *quality* of the whole class of West Point graduates may be degenerating is a fair deduction. Again, in order to secure a larger number of engineer officers, nine or ten, or even twenty a year, enter the Corps now, where only three or four entered 25 years ago; so that from six to *fifteen* that were *not* good enough for engineers even among the better men 25 years ago, *are* good enough now. This must mean *deterioration* of the material of the Corps—double deterioration. With milk, less rich, the skimmer sinks deeper. Can the cream be as good?

There is nothing in the situation so far, however, that the sweet reasonableness of our legislators might not remedy. Good pay will command better men and West Point must be made attractive not alone by brass buttons, but by gold dollars. With good men to choose from and better technical training, the initial efficiency of the Corps will be assured. After the Engineer Officer has become a practicing civil engineer, his pay ought to approximate that of men with equal responsibilities in civil life. This is nothing more nor less than a square deal. An efficient engineer should have his *quid pro quo*; one who is not efficient, his *quictus*. There is no middle ground in the administration of great Public Works. Incompetent engineers would be an appalling national extravagance. The present efficiency of the Corps is a recognized fact—and the inadequacy of the pay a recognized injustice.

The Civilian Engineers, forming the second body of River and Harbor specialists, are assistants to the members of the Corps. Civilians of the highest rank have the title of Assistant Engineer—and the ranking Civilian is the Principal Assistant Engineer. In many cases Civilians are locally in charge of offices and their work is executive, as well as technical.

The salaries are not large. It is proper that the salary of an assistant should scale a certain distance below that of the Officer of the Corps who is Chief. So the injustice to the Chief in his inadequate pay reaches the Civilian also. There are, however, signs in the air of amelioration in both.

What attracts Civilian Engineers in the Public Works of the country is the magnitude of things. To deal with big things tends to broaden the mind, and the man. It is a liberal education. To have a part in the building of the biggest ship lock in the world; to have as your hydraulic problem the reservoiring of the Great Lakes; to have under your hand the canalization of a great waterway whose commerce means a hundred millions of savings a year to the nation; these things are not petty, and have a dignity that works into men's souls. If a man takes pleasure in his work, because it is worthy—he can accept for a time a bare living with unmitigable subordination, thank God, and walk erect. There is no better, broader training than that to be gotten from the government service as an Assistant Engineer—and I am going to show later on that it has produced some strong men.

The one odious thing to the Civilian is the permanence of subordination. The chief executive positions are held as a matter of caste by members of the Corps—and there is no way in which a Civilian, however great his merit, can enter this charmed circle. The thing is as absolute as royalty—and, for a democracy, as archaic. If there is any humiliation in the position of a Civilian under the Corps of Engineers it is this. There is no legal obstacle to an Assistant Engineer becoming Secretary of War and controlling the Army. He may even hope to be President, and become Commander-in-Chief of the Army. There is not much danger that he will reach either pinnacle, but he has the same fighting chance that any other citizen has. He cannot, however, become a Lieutenant, a Captain, a Major, or a Colonel of the Corps. Why not? Because there is no legal way of doing it. A private soldier can work up through the ranks, and get his commission in the Regular Army as Lieutenant, and go on up to General; look at Funston and Miles. But not in the Engineers; the blood of West Point must flow in the veins of the dominant engineers in charge of our Public Works.

When the light is turned on this feature of the relations of the Corps and the Assistant Engineers, it reveals an unfair deal, a relic of feudalism—an unstable condition. Here is a whole class of Civilian Engineers, who have done splendid work, and who are still doing splendid work, with a clear understanding that their only hope of ultimate advancement and independent charge of work lies in getting out of the Engineer Department.

A good man, with initiative and courage, does as a rule get out of the service about the time he has reached the full maturity of his power, and has become proportionately valuable to the government; and such men strengthen the ranks of the *graduates*.

If legislation could devise a method of recruiting and strengthening the Corps by transfusing into it the best blood of the Assistant Engineers, the result would be twice blessed. It would strengthen the grip of the Corps on the Public Works of the country, and it would energize, stimulate and dignify the Civilian element—on which after all the efficiency of the organization must always most largely depend.

Andrew Carnegie, who, judged by results, knows something of business organization, gives this advice in an address to young men: "Do not rest content for a moment in your thoughts as head clerk, or foreman, or general manager in any concern, no matter how extensive. Say each day to yourself 'My place is at the top.' *Be king in your dreams.* Make your vow that you will reach that position. . . ." It is the possibility of such ultimate reward that puts men on their mettle, spurs them to live laborious days, vitalizes their work and makes it good.

The Assistant Engineers under the Corps are working without this possibility. It is caste pure and simple—a ruling class, and a serving class—and is without parallel in our otherwise democratic institutions.

Why continue in such a service? In some cases like the starving apothecary of Mantua, one's poverty, not one's will, consents. Others—and the majority, I think—see in it the good school that it is, from which they will graduate in time—with a living meanwhile.

Oliver Wendell Holmes in his preface to the "Autocrat of the Breakfast Table," speaks of a famous oculist who "had to *spoil a hatful of eyes* in learning how to operate for cataract." Is it not possible that men learning to execute engineering works may do some bungling, ruinous things? When by operating on our Public Works a Civilian Engineer has become proficient, he graduates out of the service and goes into civil practice, while an apprentice hand takes up his knife.

That the Corps, working with an organiaztion of Civilian Engineers who are not actuated by the master spring of an efficient mechanism, has accomplished in spite of this handicap, so many excellent results, is a case of winning against odds. But the weakness and fatuity of the thing is certain because it is medieval, unfair, and bad business organization. It is a house of cards, and its stability is merely that of a house of cards, and nothing more.

It is up to the Corps of Engineers to take the initiative in securing for the Civilian Engineer the same chance of limitless advancement in our Public Works that a private soldier has in the regular army, or a private citizen has in the commonwealth. It is a plain, fundamental matter of right and wrong, good and bad, safe and unsafe, stable and unstable. The *statics* of organization are about as simple as those of mechanics, and the forces tending to collapse the present structure are clearly shown.

I trust the Corps is big-brained and big-conscienced enough to line itself up with the forces that make for solidity and stability, and that the rays of future investigation will show only clean strength.

Your correspondent from St. Louis who speaks of Civil Assistants as a body of men "who almost deserve pity"— is much beside the mark. In every organization there are men of mediocre ability to whom competition and advancement are rather hopeless things. They were not created for Chief Engineers anyway, and their subordination is probably just as comfortable in the government service as elsewhere, and perhaps safer. The capable Civilian Assistants with personality, courage and initiative—the men who become *graduates* some day—need no pity. It is sometimes better to be for a time second in Rome where life is vibrating, than first in a little Iberian village where life is vegetating.

The third group of River and Harbor Specialists—the *graduates*—the men who have served their apprenticeship in the service, doubtless holds some of the strongest men in the profession. Alfred Noble, Past-President of the American Society of Civil Engineers, sometime Member of the Nicaraguan, Isthmian, and Deep Waterways Commissions, Member of the Board of Consulting Engineers on the Panama Canal, now Chief Engineer of the Pennsylvania Railroad's East River Tunnels—one of the most notable engineers in the world—worked as an Assistant Engineer under the Corps of Engineers until he was 38 years old. Another Past-President of the American Society is George H. Benzenberg; and Charles L. Harrison is a Director in the American Society—both *graduates*.

R. S. Woodward, President of the Carnegie Institution of Washington is an old Lake Survey man; so is E. E. Haskell, Director of the College of Civil Engineering of Cornell University; also Prof. J. B. Davis, of Michigan; and the late Dean J. B. Johnson of Wisconsin. Joseph Ripley, Advisory Engineer to the Department of Public Works of New York State, is a recent *graduate*.

The list of men high up in civil practice who were once in the Engineer Department under the Corps, is a long one. With such men as these blended with the strong men of the Corps, to administer Public Works, there would be no possible distinction to assimilate into the permanent fiber of the Corps the strong men now among the Civilian [illegible]

Francis C. Shenehon, M. Am. Soc. C. E.
Principal Assistant Engineer, U. S. [illegible] Survey.
Detroit, Mich., April 28, 1908.

[We have never seen a fairer, more intelligent and more hopeful and helpful discussion of these questions than the letter printed above. We commend it to the careful study alike of officers of the Corps of Engineers and of the civilian engineers who are interested in having the engineering work in connection with the planning expansion of waterway improvements proceed on a better basis.

As many of our readers know, agitation to have civilian engineers placed in control of River and Harbor work dates back fully 30 years; but it has always failed and will always fail so long as it is construed by the public and by Congress as a mere quarrel between two branches of the profession, the civil and the military engineer, as to which shall have the authority.

To be successful, appeal must be made not on behalf of the engineers, but on behalf of proper, efficient and economical conduct of our great public works. There is no reason why the army engineers and the civil engineers should not join hands and work together for reforms in the conduct of our public works which will be of mutual benefit and, what is of far more importance, will place the planning and carrying out of our Federal public works on a basis calculated to better protect the public interests.—Ed.]

THE COST OF OILING ROADS IN NEW YORK STATE.

The State Engineer's Department of New York for the past several years has been carrying on investigations into the costs and efficiency of oiling roads for the prevention of dust and the preservation of the wearing surface. The tests for the fiscal year 1905-06 have been reported by Mr. Arnold G. Chapman, who was in charge, in the recently issued report of the department for that year, and we reproduce below some extracts of the report and our own compilation of the cost data there given.

The extracts are as follows:

After an investigation of the various methods and results of treating roads with oil, tar or other hydrocarbons as a means for their preservation and for the elimination of the dust nuisance, the experimental oiling of New York roads was undertaken by the State Engineer and Surveyor in July, 1906, with a view of determining its efficiency, cost and advisability as a means of accomplishing the desired ends. Various methods of application were tried during August, September and October, on macadam, gravel and sand roads in Oneida, Albany and Orange counties, and the results of the different methods are to be noted next spring after the roads have been subjected to the wear of the fall traffic and the influence of winter conditions.

APPARATUS.—The sprinkling cart used to distribute the oil on the road consisted of a 600-gal. steel tank with a wooden head, by the Etnyer Co., fitted with a White patent oiler, such as is used in California, where the sprinkler is made. The characteristic features of this type of sprinkler are: that the oil is distributed directly downward upon the road-surface, and that the width of the application may be regulated from 18 ins. to 6 ft., as can also the amount of oil applied, by the manipulation of levers by the operator, who sits in the rear of the tank. From his position the operator can adapt the flow of oil both as to quantity and width, as the condition of the road may demand.

To unload the oil from the 6,000-gal. U. T. L. cars, in which it was received, a diaphragm pump was used, fastened to the dome of the car. By means of an iron chute the oil was conveyed from the pump to the sprinkler tank. This method was rather cumbersome and unhandy and entailed the loss of too much time in setting up the pump and in unloading the oil, but it was the best and cheapest available at that time. However, it can be greatly improved upon when the oiling is undertaken on more than an experimental basis.

OIL.—The oil used was that known as the Raglan oil, obtained through the Standard Oil Co., from their wells at Salt Lick, Ky., at a cost of 4⅞ cts. per gal., f. o. b. at the various places where used. This is a crude oil, being black and heavy, due to the presence of asphalt, of which the producers claim a 30% to 35%. When cold, the flow of the oil is slow and sluggish, but, when warm, it flows with a reasonable degree of readily.

APPLICATION.—On the several sections of road treated

The methods of application varied, some being sanded, others swept, and some treated, as left by the traffic. The methods are noted in the reports of the separate portions of road treated. While the oil was being applied, traffic was not suspended, but the people chose the sides of the road not oiled, for a few days until the oil had been taken up by the surface and did not have a tendency to adhere to the vehicle tires and to be thrown upon the garments of the people riding or on vehicles. From observation during the experiments it was noted that the best results were obtained when the surface of the road was warm and dry and the day was also clear and warm.

The various sections on which the oil was applied are described below:

(a) UTICA-PARIS MACADAM ROAD.—The first section of road to be treated was the Utica-Paris macadam road, 1¼ miles in length, on which 6,360 gals. of oil were used, the width of surface being from 10 to 12 ft. From the end of the asphalt pavement in Utica to the top of the cemetery hill one application was given to the surface as left by the traffic. For the next 800 ft., a single coat of oil was used, but for the first 400 ft., the surface was sanded ¼ in. in depth, immediately after oiling, and the next 400 ft. sanded five hours after oiling. From the Casino park south 1,200 ft. the road received a double application, the second being applied during the day following the first application. From this point south to the end of the road one coating was given, the refuse on the surface having been previously swept off with a sweeper and with brooms.

The day following the treatment of the section from Washington Mills south, it rained for 12 hours, which must be borne in mind when judging the effect of the oil upon the road, as it washed some of the oil away before it had been taken up by the surface material. Where one application is referred to, it is at the rate of 1,200 gals. per mile, as nearly as could be regulated by the levers of the sprinkler.

Two weeks after the treatment an inspection showed the section sanded to be in better condition than the others and all the sections treated were free from any dust from automobiles passing at a high rate of speed.

The oil was received on the switch at Washington Mills, which is approximately at the center of the road, making the average haul 1.25 mi.

(b) LOUDONVILLE MACADAM ROAD.—The Loudonville macadam road was treated for a distance of about one mile, adjoining the piece upon which tarvia had been placed, the width of application being 18 ft. and the amount of oil used 2,300 gals. The oil was applied to the road as left by the traffic, having a light coating of the finer wearing material upon the surface. Any oil which collected in the depressions in the road was swept out by men with brooms, who went over the road a short time after the oil was applied, thus lessening the tendency to spatter over vehicles and their occupants passing over the road after oiling. Several weeks after the oiling, the road presented a surface free from dust and which was much more resilient and more agreeable than the section not treated. The average haul on this piece of work was 1.75 mi. from the Tivoli St. switch at North Albany, where the car was placed.

(c) KENWOOD AVE. AND DELMAR-SLINGERLANDS MACADAM ROADS.—A few days previous to the application of the oil, the Kenwood Ave. road and the Slingerlands road, from the railroad crossing to its intersection with the Kenwood Ave. road, had been resurfaced with ¾-in. Saratoga trap-rock, sand being used as a filler. An excess of sand had been used on the Kenwood Ave. piece, which is also very shady; these conditions, together with the fact that it rained the day following the application, made this portion sticky, and the result was not as good as on the stretch of the Slingerlands road from the railroad to the Kenwood Ave. intersection, where very little sand had been used with the stone. The length of the stretch here treated was about 1.5 mi., the width 10 ft., 2,600 gals. of oil being used; the average haul was 0.75 mi.

(d) ELSMERE SAND ROAD.—A short stretch of unimproved sand road in the village of Elsmere was shaped with a drag harrow and then treated with oil. The length of the section was about 0.25-mi., 800 gals. being applied on a width of 10 ft. After applying the oil the road was again harrowed to mix the oil thoroughly with the sand. The average haul was 0.8-mi.

(e) DELMAR-SLINGERLANDS MACADAM ROAD.—A stretch 0.5-mi. long on the Slingerlands road from Kenwood Ave. south was oiled for a width of 10 ft., the surface being treated as left by the traffic, 600 gals. of oil being used and the average haul being 0.5-mi.

(f) CHESTER-GOSHEN GRAVEL ROAD.—The first gravel road upon which the oil was applied was the Chester-Goshen road, No. 156, this being treated for a distance of 2.8 mi. The road had been resurfaced two weeks previously, thus presenting a surface which was somewhat loose, except in the wheel tracks, where it had been firmly compacted. The total amount of oil used was 3,400 gals., on a length of 2.8 mi., the widths varying from 2,100 ft. of 6-ft. width to a maximum distance of 9-ft. width; the average haul was 2.5 mi. No treatment was given the road before the application of oil and from reports and the results observed a short time afterward, the dust was entirely laid and no trouble was experienced from the oil adhering to the tires of vehicles.

(g) NEWBURGH-WOODBURY GRAVEL ROAD.—On the Newburgh-Woodbury road, No. 42, which is also a gravel road, but had a very hard and compact surface, 1,400 gals. were applied, on a distance of one mile, the width covered being 9 ft. The road was oiled as left by traffic, the average haul being 1.75 mi.

(h) NEWBURGH-SHAWANGUNK MACADAM ROAD.—On Road No. 161, Newburgh-Shawangunk, out of Newburgh, a section of the completed road, one mile in length, was oiled as left by traffic, there being about ¼-in. of dust and fine material on the surface. One thousand, two hundred gals. were used on a strip 8 ft. wide, the average haul being 1.75 mi.

In the accompanying table, which has been compiled from the statistics as given in the report, the relative costs of applying the oil are tabulated for the eight different pieces of road, referred to in the table by the letters with which the roads are noted in the above detailed descriptions. In these cost data the expense of State labor on the work has been included, although in some work this extra cost would not apply. However, it is probably counterbalanced by the cost of transporting the oiling machinery, which is not listed in the tab'e.

In studying these data the detailed accounts of each stretch of road should be consulted to explain some of the apparent inconsistencies in total costs per mile of 10-ft. road. It will be noted that the length of haul of oil and the amount of road to be oiled have some effect upon the final costs, although not so much as the condition of the wearing surface, which is the governing influence of cost.

TABLE SHOWING COSTS OF EXPERIMENTAL ROAD OILING IN NEW YORK STATE.

Kind of road	a Macadam.	b Macadam.	c Macadam.	d Sand.	e Macadam.	f Gravel.	g Gravel.	h Macadam.
Length of road—miles	5¼	1	1½	¼	½	2¾	1	1
Average width of road—ft.	11	18	10	10	10	8	9	8
Length of oil haul—miles	1¼	1¾	¾	¾	½	2½	1½	1¾
Total costs of applying oil in dollars:								
Team (sprinkler)	$10.00	$8.00	$6.00	$2.00	$1.00	$8.00	$4.00	$4.00
Team (sweeper)	2.00	.....	.....	.....	.....	.....	.....	.....
Pumpman	.....	.....	.....	.....	0.38	3.00	1.50	1.50
Sweeper	1.00	.....	.....	.....	.....	.....	.....	.....
Outside labor	4.50	10.50	5.25	0.87	.....	.....	.....	.....
State labor	28.00	8.00	6.00	1.00	1.00	24.00	12.00	12.00
State labor expenses	15.00	4.00	2.75	.....	0.50	15.00	6.00	6.00
Total cost	$80.50	30.50	20.00	3.87	2.88	50.00	23.50	23.50
Gals. of oil used	6,360	2,300	2,600	800	600	3,400	1,400	1,200
Cost of applying oil per gal. in dollars	$0.0095	$0.0133	$0.0076	$0.0048	$0.0048	$0.0150	$0.0167	$0.0190
Cost of oil per gal. in dollars	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478
Total cost of oiling per gal. oil, in dollars	0 0573	0 0611	0.554	0.0526	0.526	0.028	0.0645	0.0668
No. of gals. oil per mile of 10-ft. road	1,100	1,280	1,730	3,200	1,200	1,540	1,560	1,500
Cost in dollars of applying oil per mile of 10-ft. road	$63.00	$78.00	$96.00	$168.40	$63.12	$97.00	$100.60	$100.20

NOTES FROM ENGINEERING SCHOOLS.

UNIVERSITY OF KANSAS.—A special series of lectures in Coal Mine Engineering is offered at Kansas University, to be given during one-half of the school year. It is designed especially for those who desire some technical training in this branch, but are unable to take the full mine-engineering course.

RUTGERS COLLEGE.—The Legislature of New Jersey has appropriated $20,000 for the equipment of the new Rutgers College Engineering Building now nearing completion. The course of mechanical engineering here will next fall be under the direction of Robert H. C. Heck, professor of experimental engineering at Lehigh University.

UNIVERSITY OF COLORADO.—On April 25 the new building for the engineering shops at Boulder was formally opened. The building is arranged in three parallel sections with modified saw-tooth roofs. The front section is built two stories high, the upper part being used for general drawing rooms. In the lower floor of this section are the wood-working rooms and in the single-story sections are the machine shops and the foundry.

UNIVERSITY OF WISCONSIN.—Prof. Carl C. Thomas, head of the department of marine engineering at Cornell University, was appointed to the professorship of steam engineering, a vacant chair in the faculty of the Madison institution since the death of Prof. Storm Bull. Dr. M. P. Ravenel, professor of bacteriology, will take charge of the hygienic laboratory and Prof. Louis Kahlenberg has become director of the new courses for the training of chemists. Associate Prof. M. C. Beebe was appointed professor of electrical engineering.

COLUMBIA UNIVERSITY.—Entrance examinations and first year study programs for the Columbia schools of engineering, mines and chemistry have been revised and so coordinated that a student need not specialize in any one of them until the experience gained during a year's study gives him a basis for judgment and choice. Among other changes, the course of mechanical engineering will be amplified by lectures on economics and industrial law, the fourth year of electrical engineering will require additional courses in machine design and steam turbines, and the course in civil engineering will be broadened by special work in tunneling and excavation, and in motor and dynamo practice.

ANOTHER COAL-MINE EXPLOSION, at the Draper Colliery of the Philadelphia & Reading Coal and Iron Co., May 5, is reported to have caused the death of four men.

THE DERAILMENT OF THE FIRST TWO CARS of a Sixth Ave. elevated train in New York City on May 7, resulted from the spiking of two rails ½-in. out of true by a reconstruction gang. According to the company, a standard-gage measure had been used on the work. The motorman was able to bring all cars to a stop without serious results.

A FIRE LOSS OF $1,500,000 was suffered by Atlanta, Ga., May 8, in a blaze which for a while threatened the whole business section. Among the two solid blocks of ruins the most conspicuous is that of the Hotel Terminal, whose 200 guests fortunately had time to escape. The fall of high power trolley and light wires, explosions in the building of the Liquid Carbonic Co., and lack of water contributed to the difficulties of the fire department. Three days later, May 11, a second conflagration caused serious loss in another part of the business section; its damages are estimated at $100,000.

SEVERAL TORNADOES IN NORTHWESTERN OKLAhoma followed one another in rapid succession between five o'clock a. m., and one o'clock p. m., May 11, resulting in the death of at least eight persons, while scores of others were seriously injured. In the vicinity of Arnett fully thirty persons are reported to have suffered broken limbs. Vici, a town in the southern part of Woodward County, has been totally destroyed, not a house being left standing.

THE BERGEN HILL TUNNELS of the Pennsylvania R. R., in which the headings of the south tunnel were joined on April 11, advanced another important step on May 7 by the junction of headings in the north tunnel. These tunnels are the last part of the great New York and Long Island extension enterprise of the Pennsylvania R. R. to go through, and there is now open passage from the west portal of the Bergen Hill tunnels all the way to the new Long Island yard, by way of the two tunnels through Bergen Hill, the two tunnels under the Hudson River to 32d St., New York, the tunnel and open-cut line along 32d St. and through the Terminal Station to Seventh Ave., thence through the two double-track rock tunnels under 32d and 33d Sts. to the East River, through the four East River tunnels to Long Island City, and thence through the approach tunnels and open cuts to the yard. Lining and finishing work alone remain to be done in order to complete the track sections of this improvement, except for some remaining full-section work in the Bergen Hill tunnels; the terminal station structure is now being erected, the excavation being completed and the retaining wall around the site in place.

The Bergen Hill tunnels are 5,910 ft. long from Weehawken shaft (the junction with the two Hudson River

tunnels) to the west portal at the edge of the Hackensack meadows. The work is under Mr. Chas. M. Jacobs, Chief Engineer, and Mr. James Forgie, Chief Assistant Engineer of the Pennsylvania, New Jersey & New York Ry., and Mr. F. Lavis, Resident Engineer of the Bergen Hill tunnel. The contractor is William Bradley.

COAL PRODUCTION IN MICHIGAN in 1907 has been reported by the U. S. Geological Survey as being 51% greater in quantity and value than in 1906 and the largest ever recorded in that state. The total output for the year was 2,035,858 short tons, having a local value of $3,600,833 as against the previous record in 1905 of 1,473,211 short tons. Of the 1907 total 29.8% or 606,718 short tons was machine mined.

RECONSTRUCTION WORK IN SAN FRANCISCO in the two years following the earthquake of April 18, 1907, comprises a total of 10,072 new buildings and 4,198 alterations, completed or under construction. The work on these 14,270 buildings is valued at $102,186,517, an average of about $7,150 each. The following table, from the San Francisco "Call" of April 26, 1908, gives the classification of these buildings. Apparently there are auxiliary expenditures of about fifteen millions to be added, making the total spent in reconstruction of buildings about $117,500,000. A map of the burned district, prepared by the California Promotion Committee, shows that the new buildings cover the burned area very uniformly. The population of the city, according to an estimate from the same source, has just about reached the same point as before the disaster, namely, half a million inhabitants. But at the same time, the suburban towns of Berkeley, Oakland and Alameda, on the bay shore opposite San Francisco, have gained some 150,000 in population.

Class.	No.	Value.
A	63	$16,452,000
B	95	7,036,671
C	1,097	33,547,219
Frame	8,817	37,139,694
Alterations	4,198	8,010,933
Total	14,270	$102,186,517

PROGRESS ON THE YUMA IRRIGATION PROJECT of the U. S. Reclamation Service is reported as follows:

The maximum discharge of the Colorado River for the month of April was 35,000 sec.-ft., the minimum, 12,900 sec.-ft. On the Arizona side of the Laguna dam the concrete walls have been carried into the outer cofferdam, thus making this feature of the work secure. Work is also progressing on the excavation of the sluiceway and placing of rock in the dam. About 250 men have been employed, working in two shifts. On the California side the concrete walls have been well advanced toward the outer cofferdam, and a steam shovel has been installed to take the place of derrick in excavating for sluiceway. On the shore end of the dam the concrete walls have been extended into the bed rock and the pavement on that portion about completed. Two hundred men have been employed on this side.

The reservation levee is now complete from Yuma to the Laguna dam, with the exception of the brush defences, which were also completed during April for about seven miles. The railroad along this levee was operated during April, giving a round-trip passenger service daily besides the work train service. Work on the Yuma Valley levees has been finished for the season. The levee is now intact from Yuma to the Mexican boundary and for this entire distance it is sufficiently high to stand any Colorado rise of record, and all but two miles of it is high enough to keep out the highest known Gila flood. The Farmers' Gravity Canal is in shape to supply water when the river gets high enough, and the concrete headworks, and the concrete foundation for the scoop wheel which is to be installed later, are provided. The pump on the Farmers' Pump canal has been operated continuously during April.

SEVERAL PRIZES FOR ESSAYS ON ECONOMIC subjects have been offered by Messrs. Hart, Schaffner & Marx, of Chicago, the awards to be made by a committee of five, as follows: Prof. J. Laurence Laughlin, University of Chicago, Chairman; Prof. J. B. Clark, Columbia University; Prof. Henry C. Adams, University of Michigan; Horace White, Esq., New York City, and Hon. Carroll D. Wright, Clark College. Five subjects are suggested for competition for those who have had an academic training, although the possession of a degree is not required, nor is there any age limit set. One of the subjects in this list is "In view of existing railway progress, should the United States encourage the construction of waterways?" Contestants for this prize will be divided into two classes: (A) any American, without restriction; and (B) undergraduates of any American college, but any undergraduate may compete for the prizes offered under (A). The Class A prizes are $600 and $400, and the Class B prizes $300 and $200, respectively. In addition to the foregoing prizes, one of $500 is offered for competitors in Class C, composed of those who have not had an academic training. Among the five subjects for this class are "The best scheme for uniform corporation accounts" and "The relative efficiency of American and European labor in manufacturing industries." Full particulars regarding the competition may be secured from Professor Laughlin.

A "STATE CONFERENCE for the Construction of Waterways" was held in Albany, N. Y., on May 1. There sessions were held, in the morning, afternoon and evening, and about a dozen addresses were delivered in all. The main subject under consideration was the canal system of the State of New York and its relation to the commercial development of the state and of the rest of the country. The principal addresses were "The Erie Canal," by State Senator H. W. Hill; "The Oswego Canal," by Mr. Luther W. Mott; "The Canals of the State of New York," State Engineer Frederick Skene; "The Champlain Canal," Mr. A. B. Fry; "Our Nation's Waterways; Their Present Condition," Congressman James H. Davidson; "Our Nation's Waterways; Their Future Possibilities," Congressman Jos. E. Randsdell, and "Methods of Transportation in Various Countries," Mr. C. P. Austin, Chief of the Bureau of Statistics of the U. S. Department of Commerce and Labor.

AN AEROPLANE FLYER, built by Orville and Wilbur Wright, of Dayton, Ohio, for the Signal Corps of the United States Army, is being given a series of preliminary trials near Manteo, N. C. The longest single flight yet reported is 2⁷/₁₆ miles at a speed of 46.8 miles per hr., but it is expected that before the trials are completed the records of Farman and Delagrange in Paris will be surpassed. The present machine of the Wrights seems to be much like their former models (described in Engineering News, Jan. 16, 1908) except that there is some modification of the steering gear so that the operator sits instead of reclines.

PERSONALS.

Mr. Chas. M. Husband, Assistant Construction Engineer of the H. C. Frick Coke Co., has resigned.

Mr. Walter E. Emery, Engineer of Maintenance of Way of the Chicago & Alton Ry. at Kansas City, Mo., has been appointed Chief Engineer of the Peoria & Pekin Union Ry., with offices at Peoria, Ill.

Mr. Irving Hawbert has resigned from the presidency of the Portland Gold Mining Co., the largest producers of Cripple Creek, Colo. Mr. F. G. Peck, the former secretary, has been elected to the vacant office.

Mr. C. S. Davis, M. Am. Soc. C. E., formerly Chief Engineer of the Massillon Bridge Co., and after the reorganization of this company, Chief Engineer in charge of contracting for the Toledo-Massillon Bridge Co., has opened an office as consulting engineer in the Ohio Building, Toledo, Ohio.

Mr. D. D. Pendleton, who has during the past 15 years occupied various positions in the manufacturing, engineering and sales departments of the Westinghouse companies, has been appointed the Pittsburg representative of the Wheeler Condenser & Engineering Co., of Carteret, N. J., with offices in the Frick Annex Building.

Mr. D. A. Calhoun, in the past connected with railroad location and construction work in the United States, Mexico, South America and the Philippine Islands, has become a member of the firm of Caccavajo, Pruyn & Calhoun, of New York, consulting engineers. These gentlemen have now also become associated with Dr. Louis Duncan and Lamar Lyndon, consulting electrical engineers.

Obituary.

Arthur Koppel, who, over thirty years ago, founded the international firm of Arthur Koppel Company, died suddenly, on May 12, in Berlin, Germany, in the 57th year of his age.

Maurice E. Haman, a young engineer employed by the Helena Power Transmission Co. on the reconstruction of the Hauser Lake Dam, fell from that structure, April 29, and was killed.

W. J. Murphy, Vice-President of the Cincinnati, New Orleans & Texas Pacific Ry., died at his home in Cincinnati, May 10, at the age of 60. He was formerly connected for many years with the Erie Railroad.

Walter Gilman Berg, M. Am. Soc. C. E., Chief Engineer of the Lehigh Valley Railroad, died May 12, at his home in New York City. He was about to leave for Washington, D. C., as the representative of the American Railway Engineering and Maintenance of Way Association, of which society he was president, to the conference of Governors in the Preservation of Natural Resources, when he was seized with a sudden attack of acute indigestion which resulted fatally. Mr. Berg was 50 years old; he had seen wide and important service as bridge and railway construction and maintenance engineer and was the author of "Buildings and Structures of American Railroads," "American Railway Bridges and Buildings," "Strength of Timber" and "American Railway Shop Systems."

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-16. Annual meeting at Washington, D. C. Secy., John M. Diven, 14 George St., Charleston, S. C.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 19-22. Annual convention at Chicago. Secy., W. W. Freeman, 29 West 39th St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 26-28. Annual meeting at Chicago. Secy., W. H. Merrill, Jr., 382 Ohio St., Chicago.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 9-11. Annual convention at Toronto, Ont. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 22-24. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-26. Annual meeting at Detroit, Mich. (In connection with convention of American Society of Mechanical Engineers.) Secy., A. L. Williams, Pratt Institute, Brooklyn, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 23-27. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 29-July 2. Annual convention at Atlantic City, N. J. Secy., Ralph W. Pope, 33 West 39th St., N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 24-25. Summer meeting at Niagara Falls, N. Y. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.—A new association is to be formed with the above name to promote a closer relationship among the chemical engineers of America. The organization meeting will be held in Philadelphia about the middle of June.

APPALACHIAN ENGINEERING SOCIETY.—This society met at Fairmont, W. Va., May 2. Among the subjects discussed were: "The Relation of the Locating Engineer to a Modern Low-Grade Trunk Line," by Mr. G. D. Brooke, Assoc. M. Am. Soc. C. E., of Morgantown, W. Va., and "Common Faults in Concrete Construction," by Mr. A. Wagner, of Newport News, Va.

ENGINEERS' CLUB OF PHILADELPHIA.—At the last meeting of this society, May 2, Mr. S. M. Swaab, Assoc. M. Am. Soc. C. E., presented a paper on "Construction Methods on Section Six, Market Street Subway." In the course of regular business the club passed a resolution endorsing the objects of the Conference to be held in the White House, May 13-15, for the Conservation of the Natural Resources of the United States.

ILLUMINATING ENGINEERING SOCIETY.—At a meeting of the New York section to be held Thursday, May 14, at the Engineering Societies Building, 29 West 39th St., New York City, Dr. E. L. Nichols of Cornell University will present a paper on "Daylight and Artificial Light." Dr. Nichols has recently made spectrophotometric comparisons of daylight under different conditions in Europe and Africa and the results of such tests will be compared with tests of artificial light.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago, Ill., on May 6, a paper, entitled "Steam Turbine Development," was presented by Prof. J. C. Thorpe, of the University of Illinois. The paper reviewed various designs for steam impact or reaction wheels, up to those of the present time, and briefly explained their distinguishing features. At present the efforts of designers are aimed largely at methods of reducing the energy losses to a minimum. Low-pressure turbines and turbines of small sizes were specially discussed; the paper also contained a review of operating results obtained from steam turbines in service. At a meeting of the electrical section on May 8, the paper presented was by Mr. F. R. Babcock, on "The Electrical Equipment of Steam and Gasoline Automobiles."

CANADIAN MINING INSTITUTE.—The itinerary of the society's summer excursion has been completed. The start will be made from Montreal on Aug. 24, and the party will proceed directly to British Columbia, where the coal mines of the Crow's Nest District, the Trail Smelter and other points of interest in the Rossland District and the big copper mines and smelter of the Boundary District will first be visited. At the town of Nelson a reception will be held. After a short journey to the South Coast another reception as well as a meeting for the reading of papers at Victoria, the capital of the province, is on the program. Here a few days' rest will intervene. Traveling back through the Rocky Mountains over the Canadian Pacific Railway's main line to Banff Hot Springs, thence via the Sault Ste. Marie line through the nickel-copper regions of Sudbury and the Cobalt District of Ontario, the journey will again be relieved by a reception at Toronto. Returning to Montreal, an inspection of the Thetford Asbestos Region and the Maritime Provinces will be made. The whole program will consume about six weeks.

ENGINEERING LITERATURE

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Two British Irrigation Engineering Books.

Reviewed by F. W. HANNA.*

THE PRACTICAL DESIGN OF IRRIGATION WORKS.—By W. G. Bligh, M. Inst. C. E., Executive Engineer Indian P. W. Department (Retired). New York: D. Van Nostrand Co. Cloth; 6¾ × 10¼ ins.; pp. 390; 249 illustrations, mostly in the text. $6, net.

IRRIGATION.—Its Principles and Practice as a Branch of Engineering. By Sir Hanbury Brown, K. C. M. G., M. Inst. C. E. London: Archibald Constable & Co. New York: D Van Nostrand Co. Cloth; 5¾ × 9 ins.; pp. 301; plates and text illustrations. 16 shillings, net; American price, $5, net.

The growing importance of irrigation in this country and the consequent increased study of the principles of correct design of irrigation structures makes the appearance of a work of the character of Mr. Bligh's timely. The subject matter of the book is in full conformity with its title and its limitation to a single phase of the field of irrigation engineering adds greatly to its value, as the time for specialization in such a broad and growing subject is at hand. The author has devoted much time to the preparation of original designs and to the review of existing structures and has succeeded excellently in bringing together in each chapter of the book many valuable and pertinent analyses, conclusions and illustrations. Unfortunately the materials of fabrication of irrigation structures and the character of the foundations on which they are built in India are somewhat different from those in this country, limiting, therefore, somewhat the utility of the work to American engineers. Stone masonry, supplemented by plain concrete, is the leading material of irrigation construction in India, whereas in America reinforced, rubble and plain concrete and timber form the principal materials of such construction. Moreover, the majority of irrigation works built in India are founded on sand, while those in the United States are quite generally built on rock, gravel or clay foundations. The designs and discussions throughout the book will, therefore, often have to be modified to suit the materials of construction and nature of foundations prevalent in this country; but the general analyses and the scientific methods of designing will be helpful in all cases and will, of course, be directly applicable in those cases where American engineers are developing works of similar materials on similar foundations.

The book contains 14 chapters. The first three relate to retaining walls, dams and weirs. These chapters are followed by a chapter on piers, arches, abutments and floors. A brief chapter is then given on hydraulic formulas, setting forth with numerical applications the most general and practical formulas used in the design of irrigation structures. Following this are three chapters on canal headworks, covering the subjects of submerged diversion weirs, undersluices and canal head regulators. Succeeding this discussion is a short chapter on canal falls, followed in turn by one on canal bridges and escape heads. Chapter 11 is devoted to canal cross drainage works; Chapter 12 to the design of channels; Chapter 13 to reservoirs and tanks; Chapter 14 to the screw gear for tank sluices and roller gates.

In the author's treatment of earth pressure in the designing of retaining walls, he has had the commendable courage to digress from the customary practice of neglecting earth friction on the back of the wall and has also ventured to lay aside the long-held theory that the center of pressure on the base of a retaining wall should come within the middle third of its length, the tenure of which has led to many extravagant designs of retaining walls. An elaborate discussion is given on plain gravity walls, and the American engineer will naturally be disappointed not to find some notice of reinforced-concrete walls.

The chapter on dams is especially comprehensive, covering gravity, arch and buttress structures in a thorough manner. The rules laid down by the author for the design of low gravity dams are particularly good, and the extensive illustrations, critical comments and suggestive redesigns of existing high and buttress dams are both instructive and interesting, although the designers of some of the criticized structures could produce some valuable evidence in rebuttal.

The author presents excellent principles of design of weirs and aims a well-directed shaft at the continued use of ogee falls by American engineers. The use of ogee weirs in America was derived from Indian practice and its continuance is largely due to their prevention of the destructive effects that obtain from ice in vertical falls, a condition with which the author is undoubtedly unfamiliar from his Indian experience. The author's objection to the use of ogee weirs and weirs of the rapid type for the purpose of securing a gentle passage of the water over them is well taken and conforms to best recent practice in this country. He points out the evil effect on the talus below the weir, due to the high velocities engendered and augmented by these forms of construction and correctly concludes that it is better to dissipate the energy of the falling water by direct impact on a specially provided horizontal fore-apron, at river bed level, thereby reducing the length of necessary masonry protection, and obtaining a deadening effect on the energy of the falling water from the depth of water below.

The treatment of the design of diversion weirs founded on sand is one of the interesting features of the book. Laying aside the new theory of the impermeable floor and hydraulic gradient, the author throughout the discussion applies the theory of frictional stability, which requires that the weight of the structure at any point in its cross section must be sufficient to counterbalance the hydrostatic head at that point, this head being the difference between the total head of water acting against the structure and that neutralized by the effective weight thereof above the point in question. The neutralizing head is computed by means of the formula $H = \frac{ZAP}{C}$, in which H equals this head, ZAP the summation of the effective weight of the structure above the point in question and C a constant having values ranging between 75 and 125, depending on the coarseness of the sand in the foundation. The determination of the values of C does not appeal to the reviewer as being sufficiently accurate to warrant the broad application of the formula made by the author. The values of C have been computed by means of the foregoing formula from a few successful weirs that may or may not have been superabundantly safe, and the quality of foundations are likely to be widely different in various cross-sections of a channel and portions thereof and in different rivers. The principle of the formula is undoubtedly sound, but careful experiments should be made to determine the proper value of C before placing implicit confidence in results obtained from it.

It is a pleasure to note the change of practice in irrigation engineering in India with reference to canal drops, as reflected by the author's discussion of such structures. In the early works relating to Indian irrigation, the ordinary weir overfall was used and a water cushion was provided below the weir to break up the impact of the falling water. The depth of this water cushion was made abnormally large, being determined from the formula $x = h^{\frac{1}{2}} d^{\frac{1}{2}}$, in which x is the depth of the water cushion, d the depth of water over the weir, and h the drop in water surface. The author devotes his entire discussion to the notched weir and states that the water cushion is no longer considered a necessity. These views are, of course, radically different from the early practice of Indian engineers. The unqualified adoption of notched falls for all cases where drift and ice are absent is unquestionably sound, but the discontinuance of the use of the water cushion will not be so readily conceded as good practice. It is believed that the depths of water cushion required by the old Indian formula are excessive and that at the same time some depth of water cushion to prevent the wear of the floor and the vibration of the structure is essential. The reviewer suggests that the following formula will give more desirable depths;

$$x = h^{\frac{1}{2}} + d - d_1$$

wherein d_1 is the depth of water in the channel below the drop and the other letters have the same significance as in the Indian formula. Such cushion protections will obviate the extremely thick floors recommended by the author in his work and will add to the safety and life of the structure.

The graphical process has been used so far as practicable throughout the book, and the mathematical analyses are elementary. The subject matter is distinctively original and essentially without duplication in other irrigation works. The style is vigorous, blunt and somewhat overconfident. Frequent discussions of American structures are given and the author invariably passes adverse criticisms on them. It appears that the only escape for the reader from a conviction that American irrigation structures are usually incorrectly designed lies in the author's failure to give them all notice in his work.

The book is comparatively free from errors of consequence, except possibly in the complicated formula given for submerged orifices (p. 116), and the incorrect reference to orifice formulas (p. 139), and in the omission of an appropriate index. The author deserves the high appreciation of the profession, however, as having published the most important work yet issued on the design of irrigation works, and his book should find a welcome and useful place in the library of every engineer, and especially every designing engineer interested in the subject of irrigation.

A work devoted to the history, description and essential principles of irrigation must necessarily be interesting and valuable, and especially so where the sources of information are India and Egypt, the two leading irrigation centers in the world. In the preface of his book Sir Han-

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bury Brown states his intention to set forth the guiding principles that should govern the practice of irrigation and to furnish illustrations of their application in existing systems, mainly of India and Egypt. This he has done in a broad and general manner. He has also inserted some historical matter. Neither investigative nor creative design is given much notice in the book and mathematical treatment of the subject of irrigation is naturally wholly omitted. The field and the purpose of the book is, therefore, entirely distinct from Mr. Bligh's work, and for these reasons the two books are in no sense duplications. The author, in attempting to treat so large a subject in a limited space of some 300 pages, has necessitated brief and unsatisfactory discussions of many of the important branches of the subject. As to the scope of the experimental and illustrative territory of the book, it has duplications in existing works on Indian and Egyptian irrigation; and as to its comprehensive treatment of the subject, earlier writers have quite thoroughly opened up the field, either individually or collectively. The author, however, has succeeded admirably in many respects in combining a comprehensive and succint treatment of his subject.

After a brief opening chapter on the profits of irrigation, there is a concise, well-written chapter on the methods of basin irrigation, followed by a third on perennial irrigation and the duty of water. The remaining ten chapters of the book relate to perennial irrigation and treat of "the drawing up of the project, the construction of the works and the utilization of the works for the purpose for which they are constructed." In conveying an idea of the manner and material of this discussion, the following titles of the ten chapters in order will be instructive: Source of Supply; Dams and Reservoirs; Means of Drawing on the Supply; Methods of Construction; Means of Distribution; Masonry Works on Irrigation Canals; Methods of Distribution of Water, Assessments of Rates and Administration; Flood Banks and River Training; Agricultural Operations and Reclamation Works; Navigation. A glance at these titles is sufficient to convey an idea of the necessarily limited and general treatment accorded the essential divisions of the subject of irrigation, as an exhaustive discussion of almost any one of them would comprise a space larger than that devoted to all of them.

In a condensed treatment of a broad subject there is always danger of enlargement of details of portions thereof to the exclusion of more important matter. While the book under review is comparatively free from this error, its author has fallen into the trap in the compilation of two or three of the chapters. This is particularly true of the chapter on construction, where practically the whole discussion is devoted to the methods of handling water in foundation work. No information is given of other broad features of the subject, such as the organized force of execution, supervision and inspection, the nature and efficiency of requisite equipment and the fabrication of the construction materials into structures. A few words are devoted to the nature and comparative fitness of various materials of construction, in which the author condemns the use of reinforced concrete as being untested by the object-lessons of time. It may be that American engineers having been led by the success of reinforced concrete in dry construction are somewhat precipitate in the adoption of this material for wet construction. The questions of the deterioration of bond and of the rusting of the reinforcement are serious ones that time alone will answer satisfactorily.

The book reflects wide reading on the part of the author and is written in exceptionally good English for an engineering work. The subject matter, on the whole, is logically and pleasingly presented. The irrigation engineer will find pleasure and value in reading the book but not in studying it. The engineer in other branches of engineering will be able to obtain a comprehensive view of the subject of irrigation from this book, and it is in this field that the usefulness of the work mainly lies.

A Symposium on Clean Safe Milk and How to Get It.

MILK AND ITS RELATION TO THE PUBLIC HEALTH.—(By Various Authors.) Bulletin No. 41, Hygienic Laboratory, Public Health and Marine-Hospital Service of the United States. M. J. Roseneau, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 758; 50 illustrations, partly in the text. 75 cents.

With the publication of its earlier Bulletin (No. 35) on Typhoid Fever in the District of Columbia,* and the present volume on Milk, the U. S. Public Health and Marine-Hospital Service has fully entered upon a far broader field of usefulness than it has occupied heretofore. The present volume is in part an outgrowth of the typhoid fever investigation of 1906, which "brought out many facts emphasizing the possible danger of milk as a carrier" of typhoid. But the investigation of the milk question has been broadened to include all of its relations to the public health, and these relations are for the most part here treated in their broad, and one might almost say universal, aspects, instead of being confined to conditions affecting the District of Columbia alone. Enough of the volume, however, does relate specifically to the District of Columbia to give the work that more practical character that always comes when an investigation of this sort is applied to a particular city or district.

The volume consists of some 20 papers by as many authors (mostly specialists). These papers deal with almost every phase of the public milk supply. They are prefaced by an introduction by Dr. Walter Wyman, Surgeon-General, Public Health and Marine-Hospital Service, in which he first reviews the general subject and then summarizes each of the papers.

Perhaps the contributions of most interest to our readers are those dealing with "Sanitary Water Supplies for Dairy Farms," by Dr. B. Meade Bolton; "The Milk Supply of Cities in Relation to the Epidemiology of Typhoid Fever," by Dr. Leslie L. Lumsden; "The Chemistry of Milk," by Doctors Joseph H. Kastle and Norman Roberts; "Sanitary Inspection and Its Bearing on Clean Milk," by Ed. H. Webster; and a review of the milk-supply regulations of the District of Columbia, by Dr. William C. Woodward, Health Officer. The tabulations of epidemics of typhoid fever, scarlet fever and diphtheria attributed to milk, by Dr. John W. Trask, should prove particularly valuable to health officers, while those relating to typhoid outbreaks may be useful to engineers and water-works superintendents who are liable to be called upon at any time to establish the fact that excessive typhoid fever death rates may be due to other causes than the public water supply. Mention should also be made of the valuable report on the pasteurization of milk, by Dr. M. J. Roseneau, Director of the Hygienic Laboratory of the U. S. Public Health and Marine-Hospital Service, and of the extensive report on ice cream, by Dr. H. W. Wiley, Chief of the Bureau of Chemistry, U. S. Department of Agriculture.

Perhaps the most important and at the same time the most needed sections of the report are those showing the alarming degree to which public milk supplies are now held to be responsible for the spread of tuberculosis. Inasmuch as tuberculosis in its various forms is responsible for some 10% of all the deaths that occur throughout the country, it is certainly high time that everything possible should be done to control the disease at its sources, one of the chief of which is without doubt the dairy cow.

In view of the size of the report and the vast amount of valuable information that it contains, perhaps it will hardly seem justifiable to suggest that anything further should have been added to it. But it certainly would have been helpful had the report contained a digest of the state and municipal legislation designed to aid in securing safe milk supplies. Considerable space is given to such legislation and to accompanying supervisory work in the District of Columbia, but scarcely anything is said regarding the carefully wrought legislation and very creditable work that is being done by a considerable number of municipalities throughout the country. Although the report shows so admirably the need for the tuberculin test of all dairy cows in order to protect milk consumers from tuberculosis, yet it contains no intimation that this test is required by a number of municipalities distributed from the Atlantic to the Pacific.

It would be an injustice to conclude notice without stating that it was "through the interest of Dr. G. Lloyd Magruder," who has long been engaged in a campaign for pure milk for Washington, that the President and the Secretary of the Treasury directed the U. S. Public Health and Marine-Hospital Service to invite the cooperation of the Bureaus of Animal Industry and Chemistry of the U. S. Department of Agriculture to make the investigations and report which is here noticed. It is to be hoped that this valuable symposium on the public milk supply will be the forerunner of many others on public-health subjects in which the various branches of the government will cooperate.

*See abstract and editorial discussion, Eng. News, July 1, 1907; also brief notice in this Supplement for July, 18, 1908.

Sewage Treatment.

Reviewed by GEORGE W. FULLER,* M. Am. Soc. C. E.

METHODS AND DEVICES FOR BACTERIAL TREATMENT OF SEWAGE.—By William Mayo Venable, M. Am. Soc. C. E., Assoc. M. Am. Inst. E. E. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 236; 3 plates and 44 text illustrations. $3.

In the introductory chapter of this book is given an interesting statement of investigations made by bacteriologists and chemists in throwing light upon modern works for sewage purification. It is the author's viewpoint that while many problems in the practical art of sewage purification must be solved by the engineer alone, yet he must be sufficiently familiar with bacterial and other processes involved in order to design works properly. That is to say, the engineer must know how the character of sewage and the action of bacteria and other organisms make the passage of sewage through engineering works different from the passage of pure water.

A chapter is next given on the sources of information about sewage purification, the most striking feature of which is that but little reference is made to work on large projects in this country during the last four years. Almost no reference is made to the developments at Columbus, O., Baltimore, Md., Paterson, N. J., etc., as set forth in extended reports on sewage disposal at those places, or to the results of extensive tests made during recent years by the Massachusetts State Board of Health at Lawrence, or the tests conducted at the station of the Massachusetts Institute of Technology at Boston. A list of articles appearing in a number of the leading technical journals is given for the period June, 1905, to October, 1907.

Disposal by dilution, sewage farming and intermittent sand filtration are taken up briefly in about a dozen pages. The information given is of interest to the general reader, but will impress the sanitary engineer as quite meager from the standpoint of important data available in this country.

The mechanical removal of sludge is touched upon sparingly, as regards sedimentation and chemical precipitation, but is entered into at some length as regards a description of special tanks or devices which have been patented during the past 30 or 40 years. The anaerobic treatment of sewage is taken up somewhat similarly, although the extracts from a paper prepared a few years ago by Mr. Leonard Metcalf and a statement of the objects which a septic tank should be designed to accomplish leave the matter in a more satisfactory light.

The chapter on "Intermittent Contact Systems" is perhaps the most satisfactory one in the book and affords interesting reading, not only to the general reader, but also to the sanitary engineer. A good outline is also given of the leading automatic discharging devices used for regulating the flow of sewage to and through the filters.

*Of Hering & Fuller, Consulting Engineers, 170 Broadway, New York City.

The chapter on percolating or sprinkling filters has some well-arranged descriptions, but leaves the subject in quite an unsatisfactory light, as viewed from the standpoint of American practice during the last few years. References to practical experiences with this type of filter in Europe are very meager and in a few cases not altogether correct. For instance, it is stated that the percolating filters at Chesterfield, England, with their jets and spray plates, are the best known and most frequently described of the type of filters to which the liquid is applied with jets and sprays.

The remainder of the book is devoted to a summary of engineering principles regarding the design of sewage purification works and to an outline of the difficulties experienced in some actual installations with which the author was connected and from which he is led in the concluding chapter to make suggestive designs to meet typical conditions. There is much interesting reading in this book and the author's idea as to the importance of intelligent supervision is thoroughly sound. His experience with several installations in the Central West deals somewhat with specifications. However, the subjects of comparative efficiencies and costs, size of filtering material, rates of filtration, depth of beds, etc., are left in a rather unsatisfactory state.

Hydraulics.

Reviewed by GARDNER S. WILLIAMS,* M. Am. Soc. C. E.

HYDRAULICS.—By F. C. Lea, Assoc. M. Inst. C. E., Lecturer in Applied Mechanics and Engineering Design in the City and Guilds of London Central Technical College. New York: Longmans, Green & Co. London, England: Edward Arnold. Cloth; 5¼ × 8¾ ins.; pp. 536; 367 illustrations in the text. $5, net.

HYDRAULIC ENGINEERING.—A Treatise on the Properties, Power and Resources of Water for All Purposes. By Gardner D. Hiscox, M. E., Author of "Mechanical Movements," etc. New York: The Norman W. Henley Publishing Co. Cloth; 6 × 9¼ ins.; pp. 315; 306 illustrations, partly in the text, and 36 tables. $4.

PRACTICAL HYDRAULIC (WATER SUPPLY AND DRAINAGE) TABLES AND DIAGRAMS.—By C. E. Housden, Superintending Engineer P. W. D. India. New York and London: Longmans, Green & Co. Cloth; 4¾ × 7¼ ins.; pp. 105; 6 plates and 8 text illustrations. $1.25, net.

The reviewer has often had occasion to remark the superiority of the mathematical training furnished by the English universities over that afforded by those of our own country. He has also observed that a treatise upon any mathematical subject by a thoroughly educated Englishman always transcends the works of its class produced on this side of the water. Professor Lea's book is an excellent example of the foregoing, and though its illustrations are largely from English practice, they are so well chosen that the reader often sees, in their analysis, the principle of the American machine equally well set forth, although the latter is not even mentioned.

The author has confined himself to the more limited definition of hydraulics and no attempt is made to include pneumatics or earth pressures. The work begins with a brief historical review of the general science, and later on the history of some of its subdivisions is related. In Chapter I. the ordinary principles and equations of hydrostatics are briefly presented, with a discussion of the differential gage and of pressures upon immersed surfaces. A somewhat notable omission is that of the stability of dams, but as the treatment of this subject usually presented is entirely inadequate, the book in hand does not suffer materially in comparison. Chapter II. is devoted to "Floating Bodies" and includes the subjects of metacenter, the stability of ships and pontoons and vessels containing liquids.

Chapter III. takes up "Fluids in Motion" and presents Bernouilli's theorem and its applications, the demonstration given being that by means of the equation of work and change of kinetic energy. "Flow Through Orifices and Over Weirs" is treated in Chapter IV. Casting aside the usual references to orifices the more recent and accurate results of Bazin are used as the basis of the discussion, and the work of Poncelet and Lesbros, and Hamilton Smith, Jr., are drawn upon, as well as the nozzle experiments of Freeman. A very good resumé of the weir investigations of Bazin follows, with references to those of Francis, Fteley and Stearns, Hamilton Smith, Jr., and the Cornell experiments; and finally Boussinesq's Theory of Weir Discharge is presented. Chapter V. deals with "Flow Through Pipes." The fundamental ideas and equations of flow are first developed, after which empirical formulas are discussed. The Chezy, Darcy, Kutter, Reynolds and the general logarithmic formulas are analyzed and the experimental data upon which they are based is examined, including the recent material presented to the American Society of Civil Engineers. The distribution of power through pipes is also considered.

In Chapter VI., entitled "Flow in Open Channels," after the Chezy, Prony, Eytelwein, Darcy and Kutter formulas, there is presented a very complete discussion of Bazin's recent formula, and finally a group of five logarithmic formulas covering the various kinds of channels, which range from $S = 0.000065 \frac{V^{1.72}}{R^{1.25}}$ for very smooth conduits to $S = 0.00085 \frac{V^{2.1}}{R^{1.3 \text{ to } 1.5}}$ for very rough natural channels. For earth channels the author recommends $v = C\sqrt{R^{1.5} S}$, with $C = 50$ for ordinary conditions, which is identical with the formula proposed by Marvin E. Sullivan some ten years ago. Comparison of these several formulas with experimental results are also presented. The distribution of velocities in streams is discussed and discharges of irregular and horseshoe sections are investigated.

"Gaging the Flow of Water" comprises Chapter VII. While the treatment of float gagings is not so complete as might be wished, that of the Pitot tube is the most satisfactory of any text-book yet published. Measurement by weighing, current meter, Venturi meter, Deacon meter, orifice, nozzle, and ordinary water meters, as well as by chemical means, is also considered, though the American disk water meter is not included. This completes what might be designated the first section of the book.

Chapter VIII. takes up the "Impact of Water on Vanes." The author adopts the method of vector representation for his analysis, and by this too little known device is able to greatly simplify the treatment, not only of the subject of the chapter but also of "Water Wheels and Turbines" which follows. The completeness of the treatment may be judged by the fact that not only is the analysis of inward, outward and parallel flow turbines given but also that of the mixed flow wheel, for which the method of design is developed. Governors of European types are described and an investigation of water hammer in penstocks is presented.

Chapter X., on Pumps, deals first with the centrifugal, and then with an inward and a parallel flow pump, concluding with the reciprocating pump, the hydraulic ram and the air lift. The action of water in the pump cylinder, the effect of air chambers, and positive and negative slip are mathematically examined with a completeness not usually met.

Chapter XI. treats of accumulators, intensifiers, hydraulic presses, engines and cranes.

In Chapter XII. Froude's classic experiments on the resistance to the motion of bodies in water are examined and the relations between a ship and its model are established, and in Chapter XIII. the book concludes with a consideration of stream-line motion, including Hele Shaw's experiments, and the vortical equations.

Each subject treated is followed by a considerable number of problems and examples which give every evidence of being drawn from an extensive practice. Altogether, there are 217 besides those solved in the text, and this list alone is almost worth the price of the book.

The English gallon is used throughout the book, which will be a slight disadvantage to American readers, and the references to the publications of the American Society of Civil Engineers are unfortunately usually to "Proceedings" rather than "Transactions." A few misprints in proper names and in dates occur in the text, but the number of errors is surprisingly small. The press work and illustrations are much better than the ordinary English text-book, and the arrangement in large and small print, respectively, of the more and less important portions, is especially worthy of commendation. The author writes as one having authority and altogether the book appears to the reviewer as the most satisfactory treatment of its subject for the English speaking student that has yet appeared.

Mr. Hiscox's work begins with an historical chapter which reminds one of Ewbank, but lacks the virtue of references to the authorities which the older book possesses. The author then takes up, in succession, to quote chapter heads,

The Properties of Water; Measurement of the Flow of Streams; Flow from Subsurface Orifices and Nozzles; Flow of Water in Pipes; Siphon and Water-ram; Dams and Reservoirs; City and Town Water Supply; Wells and Springs; Air Lift; Artesian Wells; Irrigation of Arid Districts; Water Power and Water Wheels; Pumps and Pumping Machinery; Hydraulic Power Transmission; Hydraulic Mining; Canals, Ditches, Conduits and Pipe Lines; Marine Hydraulics; and Tidal and Sea Wave Power.

The treatment throughout is rather encyclopaedic and often no particular relation between contiguous matter is apparent. An illustration of an "Overflow Dam" shows the sheet increasing in thickness as it falls. Many of the illustrations have a familiar look, but no reference to their source appears. The name is rather a misnomer. If it were entitled "Hydraulic Craftsmanship" little criticism could be made, but it is no more a treatise on hydraulic engineering than a spelling book is a dictionary. So long as its members put forth such works under the guise of engineering the most learned profession will continue to be classed with bricklaying and ditch digging. As a supplement to a trade catalog or a guide for a millwright, the work may be useful, but it has no place in a professional engineer's library.

The following from the preface may be taken as a criterion of the value of Mr. Housden's book:

Further, as the exact sizes of pipes, sewers, and drains from ¾ in. to 60 ins. in diameter (to the nearest 1/10 in.) and from 5 ft. (60 ins.) to 13 ft. in diameter (to the nearest inch) can be ascertained from them (and the accompanying formulas), for all gradients likely to be ordinarily needed, they are sufficiently full to meet any reasonable requirement.

We should think so.

The tables are based upon the formulas of Messrs. Ganguillet and Kutter for the calculation of the flow in pipes and channels, which the author states "are now universally accepted as the most accurate in use for such a purpose." The author's view of the universe evidently excludes France, Great Britain and a considerable portion of the United States.

Examining the book more closely one finds that only about twenty of the 105 pages are tables or diagrams, and without reading more or less of the 85 other pages it would be difficult to ascertain just what the numbers in the tables are intended to indicate. It may be a very useful work for some people, but not for those familiar with any of the American books of hydraulic tables.

GRACE'S EARTHWORK TABLES.—London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 10 × 12 ins.; pp. 72. 12s. 6d., net; American price, $5.

These tables give contents in cubic yards of ground on uniform transverse slope and uniform longitudinal grade, for lengths of one chain (66 ft.), roadway widths of 12, 15, 18, 20, 26, 27, 28, 30 and 50 ft. and side slopes of ¼ on 1, ½ on 1, 1 on 1, and 1½ on 1. For the limited field they cover, the tables should be of great value, as they are remarkably clear and concise, but the additional transformation from 66 ft. chains to 100-ft. stations necessary for American practice will somewhat hamper their usefulness in this country.

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Lectures on Municipal Ownership.

MUNICIPAL OWNERSHIP.—Four Lectures Delivered at Harvard University, 1907. By Leonard Darwin, Author of "Municipal Trade." New York: E. P. Dutton & Co. Cloth; 4¾ × 7¼ ins.; pp. 149. $1.25, net.

As we stated in reviewing "Municipal Trade" (Feb. 18, 1904), Major Darwin was the author of the first book to take up in a dignified, systematic and comprehensive manner the arguments against municipal ownership. The earlier volume was somewhat ponderous; but the one before us, consisting of a short series of lectures delivered at Harvard University in 1907, is easy and agreeable reading. The present book is to some extent an epitome of the larger one, but has the advantage of not only greater brevity and conciseness of treatment, but also of including the later ideas of the author and of presenting the subject in a way designed to make it particularly useful to Americans.

The author holds that the vital question at issue is not so much municipal ownership as it is whether or not labor should be directly employed by municipalities. Running through the whole book there is evident a strong undercurrent in favor of municipal ownership and private operation of many of the so-called public utilities. The author also recognizes the importance of having franchise companies under strict public regulation. He expresses himself as in favor of short-term franchises. If municipalities would avail themselves of private operation under municipal ownership, and of strict regulation of franchise companies under short-term franchises, most of the advantages recognized by the author as appertaining to municipal ownership would, in his opinion, disappear.

As to the net financial loss or gain, Major Darwin does not see very much difference between municipal and private ownership, but on the whole he seems to believe that municipalities and also the country at large would be better off financially with private than with public ownership. He is clearly of the opinion that existing British statistics do not make it possible to determine which ownership plan is preferable. In saying this, he is not reflecting upon the character of the statistics, but is making a statement that applies to the statistics of the subject generally, even under the best conditions, since so many factors enter into the question—and particularly factors that vary with municipalities and other conditions—that it becomes more a question of expediency than otherwise to determine which ownership plan is most desirable for a given city.

One of the four lectures is devoted largely to municipal corruption. The author states that English civic purity has not increased concurrently with municipal ownership, but is of older date. Municipalization makes corruption on the whole less easy to cure.

The proposition for disfranchising municipal employees, made by many writers, does not appeal to Major Darwin as likely of achievement. He suggests, in place of this, giving all municipal employees direct representation on town and city councils.

As in the earlier book, the author seems to think there is little question but that waterworks should be municipally-owned and operated, although he would prefer to see them constructed by contract rather than by direct municipal employment.

The last part of the closing lecture is devoted to a discussion of "socialistic ideals in municipal ownership." This discussion, though in many respects interesting, is based so largely on imaginary conditions as to be almost wholly academic.

We take pleasure in commending the book as a fair presentation of most of the stronger of the arguments against municipal ownership, while at the same time reviewing, often with approval, some of the arguments for municipal ownership. It is interesting to note that Major Darwin was for some years a member of the British Royal Engineers, and that he is the fourth son of Charles Darwin.

Power and Power Transmission.

Reviewed by AMASA TROWBRIDGE,* M. Am. Soc. M. E.

POWER AND POWER TRANSMISSION.—By E. W. Kerr, M. E., Professor of Mechanical Engineering, Louisiana State University. Second Edition, revised. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9 ins.; pp. 366; 264 illustrations in the text. $2; English price, 8s. 6d., net.

By confining himself almost entirely to descriptions, the author of this book has gone over the subjects of which he treats very broadly. The book is divided into three general parts, the first of which treats of machine elements, the second of "steam" prime movers and the third of various other prime movers. This arrangement has a decided advantage by taking up the subjects in the order of their complication. As the book is intended for the use of students or beginners this is important.

To call attention to the principles treated in a chapter, the author has placed at the end of the chapter a number of problems that relate to the subjects in it. This not only brings out those parts of the subjects which are important, but shows the reader how the principle may be applied in practice. This is an excellent feature for a book of this character, as it introduces some of the general mathematics of the subject.

In the first subdivision of the book the author not only treats of the usual elements of machines, such as shafting, pulleys, gears, belts, cams and levers, but has also included pipe fittings and valves. The second subdivision, on steam-power, describes the various types of boilers and their accessories, such as settings, stacks, stokers, etc., and also treats somewhat of fuels. The indicator and various valve gears are described and a brief outline of the valve-diagram is given. A chapter is devoted to rotary engines and steam-turbines, in which the principal advantages of the rotating motor over the reciprocating motor are pointed out. In the third division, water, gas, oil and air engines are considered. The latest practice in gas engines is not quoted, but should have been. This subject should also have been treated much more fully, even in a book of this character. Gas engines are such an important factor in power generation that a student should be taught to consider them as relatively important.

One fact seems peculiar, namely, that in a book on power transmission no mention should be made of the simplest and most efficient device we have for that purpose, the electric generator and motor. This is the author's most serious omission. The book is unquestionably good for an introduction to the subject of power transmission and generation, but it is merely a compilation of information which can be found in greater detail elsewhere.

ACCIDENTS.—Their Causes and Remedies. A Treatise of the Development of Care and Faithfulness to Aid the Safeguarding of Life and Property. By Thomas D. West, M. Am. Soc. M. E. Greenville, Pa.: Beaver Printing Co. Paper; 5¼ × 7¾ ins.; pp. 95; illustrated.

It is the theory of the author of this pamphlet that the larger proportion of the many accidents which yearly destroy the lives and usefulness of our citizens is due to a growing tendency toward carelessness and recklessness which is fast becoming a racial fault, encouraged by a lax system of instruction to our youth. In his mind, to prevent these accidents, we must go further back than the safety device, and teach our children the principles of care, of faithfulness and sincerity, of responsibility and concentration of mind, so that the general morale of the country will rise to such a point that accidents will become what they really should be, unforseen mishaps for which no person has either a physical or moral responsibility. Aside from an altogether too pronounced pessimism regarding the general decrease in the mental and moral standard of youth—a feeling common enough among the mature since Adam superintended the education of Cain and Abel—the ideas advanced by Mr. West are well worth the study of all who realize the necessity of limiting the loss to the country occasioned by the multitude of preventable accidents.

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COMPETITIVE DESIGNS FOR CONCRETE HOUSES OF MODERATE COST.—(Ranging from $2,000 to $4,500 each.) Philadelphia, Pa.: Association of American Portland Cement Manufacturers (1312 Land Title Building). Boards; 15 × 19¼ ins.; numerous illustrations. $1.

The prize designs in the competition for concrete houses of moderate cost, instituted by the Association of Portland Cement Manufacturers, received considerable publicity at the time the results were first announced in various periodicals about a year ago, but the interest has been so great that the association decided to compile them in a portfolio, in which all drawings and descriptions are reduced to a standard so that a more direct comparison of the merits of the various designs may be made. The competition was upon two classes of houses, the first for single or detached dwellings and the second for twin or semi-detached houses. In each class three prizes were offered for each of three divisions, based on first cost, viz.: houses to cost not more than $2,000, not more than $3,000 and not more than $4,500. There were, then, 18 prizes offered, but the present portfolio contains 25 designs, seven honorable mentions being included in the list. Each design is accorded double facing pages of the large portfolio sheet, with elevations, sections, floor plans, perspective, description and cost data.

FOWLER'S ELECTRICAL ENGINEER'S POCKET BOOK.—Edited by William H. Fowler, M. Inst. C. E., M. Inst. M. E. Manchester, England: Scientific Publishing Co. Leatherette; 3⅝ × 6¼ ins.; pp. 679; illustrated. 1s. 6d., net; post free, 1s. 9d.; American price, 60 cts., net.

Fowler's Electrical Engineer's Pocket Book is an acceptable companion to the same author's Mechanical Engineer's Pocket Book. Each is published annually at such an absurdly low price that most any engineer will be willing to give away his old editions and get up-to-date ones each year. There are included in the 1908 edition the usual conversion, mathematical and wire tables and sections on magnetic quantities and measurements, electrical instruments, batteries, illumination, on the design and management of direct and alternating-current machinery, on electric traction, etc., etc. Wiring rules, etc., are appended, but these, of course, are applicable only in England, as this is distinctively an English book.

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Steam and Hot Water Heating.

Reviewed by WILLIAM KENT,* M. Am. Soc. M. E.

PRACTICAL STEAM AND HOT WATER HEATING AND VENTILATION.—A Modern Practical Work on Steam and Hot Water Heating and Ventilation, with Descriptions and Data of All Materials and Appliances Used in the Construction of Such Apparatus; Rules, Tables, etc. By Alfred G. King, Author of "Steam and Hot Water Heating Charts," etc. New York: The Norman W. Henley Publishing Co. Cloth; 6 x 9 ins.; pp. 402; 304 illustrations in the text and 68 tables. $3.

This book is a work especially designed for the practical steamfitter. It describes and illustrates the principal apparatus that the steamfitter uses in constructing a system of heating and ventilating, using steam or hot water as the heating agent. Numerous illustrations are given of various styles of boilers and hot water heaters, boiler settings, pipe and pipe fittings, valves, forms of radiating surfaces, methods of piping for steam and hot water, etc. Heating by exhaust steam, pressure systems of hot water work, hot water heating appliances, methods of heating greenhouses, vacuum, vapor and vacuum exhaust heating, the heating of swimming pools and miscellaneous heating are described at length.

The matter above mentioned occupies the first half of the book. In the second half a chapter of forty pages is devoted to ventilation. This subject is discussed in the usual way, beginning with the amount of air necessary for ventilation and describing different methods that are in use. Considerable space is devoted to the description of blower heating and ventilating systems. Steam appliances, such as traps, separators, feed-water heaters, pumps, reducing valves, etc., are next described; then follow brief chapters on district heating, pipe and boiler coverings, temperature regulation and heat control, estimates and specifications and miscellaneous notes, rules and tables.

The book will be found useful for giving information to steamfitters and other practical mechanics interested in the subject of heating and ventilation. It may also be recommended to the apprentice in these trades. It will not appeal to engineers who have much better treatises on heating and ventilation in their possession. The book contains very little theoretical treatment of the subject and what little there is should be revised by an expert. Some of the expressions in the book are also examples of faulty English construction and lack precision or accuracy as statements of engineering theory. The following are examples:

> The nature of heat is peculiar and it is well that we become somewhat acquainted with these peculiarities.
> The British system of measuring heating work or the effect produced by the action of heat is by what is known as foot pounds.
> The horse-power represents the energy developed by evaporating 2,655 lbs. of water into steam, and it is sufficient to supply 100 sq. ft. of radiation.

The author is an advocate of steam or hot water heating as being superior to furnace heating. For the latter he has strong antagonism and some of the statements he makes concerning it are lacking in accuracy. For example, he says:

> The air is devitalized by passing over metal heated often to 1,200 or 1,500° F., which robs it of all its health-giving properties.

This is a statement that is frequently made by salesmen of steam and hot water heating apparatus, but any one who knows what is the composition of air, knows that it is entirely untrue.

The book is well printed and the illustrations are excellent.

*Dean of College of Applied Science and Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y.

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Concrete.

CONCRETE.—By Edward Godfrey, Structural Engineer for Robert W. Hunt & Co. Book Two, Structural Engineering. Pittsburg, Pa.: The Author. Flexible leather; 3¾ x 6¾ ins.; pp. 448; numerous illustrations in the text. $2.50, net.

The engineering world is patiently prepared to be deluged for the next few years with works on the design and construction of concrete, for so admirable an opportunity for the making of engineering literature has not come to the hands of the bookishly inclined these many years; in fact, there has never been a time when one material has sprung into general use in so short a period that it outgrew its literature. In the other structural materials the growth has been slow, with gradual increases in knowledge which called forth at certain intervals fresh literature to correct erroneous previous impressions, and to record additional data. In concrete, practice has been, and to a certain extent still is, in a formative state, so that it is only quite recently that a definite work on the subject could be written. Even now the utility of a master work on concrete is doubtful, but there is need for a concrete handbook which will avoid the more complicated theory for the details of practice in field and office.

This latter want Mr. Godfrey has attempted to supply, but the attempt can hardly be called successful, principally because of the almost entire absence of any systematized arrangement or selection, and on account of the disregard of most of the rules for the make-up of a readable book of instruction and reference. It is a common error among engineers to subordinate manner to matter, but in no line of work is this error more damaging to success than in the making of books. If the most necessary information be inconsequently set down amidst less important material, it is so deprived of its intrinsic value as to make it nearly useless to the ordinary reader who has neither the time nor the ability to separate the good from the bad.

When an author sets out to compile matter which has previously appeared in periodical form, a respect for the more complete treatment needed in a finished book should require that study be made to eliminate from the book those qualities which the less rigid standards of current literature allow. This standard Mr. Godfrey has not adhered to. By far the greater part of the book is made up of articles contributed by the author, during the past two years, to Engineering News and "Concrete Engineering." The reproduced matter has been taken bodily from the original and set down in the order of appearance, together with a detailed correspondence upon disputed points, displaying a proficiency in and avidity for argumentation seldom met with away from the debating stage. This correspondence was of certain value in the original, but is decidedly out of place in a book, in the compiling of which a few hours' time would have sufficed to incorporate the sense of the correspondence in the main text. To be required to follow a slender line of reasoning through a labyrinth of complimentary allusion and defensive argument is sometimes necessary in periodical literature, but can hardly be allowable in the more permanent book.

In his theory the author is sound; the main objection to his presentation—always remembering the continual violation of the laws of selection and unity in his composition—is an almost too apparent didacticism and a slight intolerance of any other views but his own.

The book starts with a chapter headed "A Survey of the Field of Concrete Design and Construction, in which will be Found Some Theses," which is a rapid survey of the scheme of the book. This is followed by a short treatment of the materials which go to make up concrete structures, and the methods of handling, finishing and constructing the concrete. Next there are given some isolated cost figures of no exact value, as the conditions under which the work was carried on are omitted. This completes the original portion of the book. There follow articles from Engineering News: "The Design of Concrete-Steel Beams and Slabs," "The Design of Reinforced-Concrete Columns and Footings," and "The Design of Reinforced-Concrete Retaining Walls." The "Concrete Engineering" articles come under the following heads: "Reinforced-Concrete Engineering in the Making," "The Design of Reinforced-Concrete Beams and Slabs," "The Design of Reinforced-Concrete Arches," "The Design of Foundations," "Shear of Concrete and Its Bearing on the Design of Beams," "The Design of Reinforced-Concrete Columns," "Design of Dams," "Design of Reinforced-Concrete Chimneys," and "The Design of Domes, Vaults and Conical Coverings." The book is completed by some thirty pages of cuts illustrating various concrete structures. The author notes the fact that necessarily there is some repetition in the articles from the two periodicals mentioned, for the correction of which he does not consider it worth while to take time or trouble.

As can be seen from these headings, the plan is ambitious and it seems a pity to have it fall so far short of its proper usefulness on account of easily-corrected details of arrangement and composition. The physical make-up of the book only adds to the confusion. The paper and printing are not of the best; there is no table of contents; the index is of little value; the chapter headings are not numbered and are started regardless of their position on the page; there are no page headings nor subheads, so that in a search for certain material there is a wearisome turning of pages until the correct chapter heading is found. These are but details of book-making which are due no doubt to the fact that the author is his own publisher, but that they were overlooked marks just the difference between a makeshift and a useful handbook.

The present book is uniform in style of printing and make up with the book published by the same author under title "Tables, Structural Engineering, Book I.," and reviewed in Engineering News on Feb. 15, 1906.

DIRECTORY TO THE IRON AND STEEL WORKS OF THE UNITED STATES.—Compiled and Published by The American Iron & Steel Association (261 South 4th St., Philadelphia, Pa.). 17th Edition, Corrected to March 1, 1908. Cloth; 5½ x 8¾ ins.; pp. xvi. + 500. $12; English price, 50s.

The American Iron and Steel Association in this volume have issued the regular number of the directory of the iron and steel trade in this country, a compilation, as they say in the preface, of "the blast furnaces, rolling mills, steel works, forges and bloomaries, and tinplate and terne plate works in the United States." The work is too well known among those to whom it is of interest to enter into a description of or comment on its contents, which are similar to those in the past and of a size increased with the proportions of the industry it represents.

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Reviewed by BRADLEY STOUGHTON.*

THE BLAST FURNACE AND THE MANUFACTURE OF PIG IRON.—An Elementary Treatise for the Use of the Metallurgical Student and the Furnaceman. By Robert Forsythe. New York: David Williams Co. Cloth; 6 × 9¼ ins.; pp. 368; text illustrations, $3, net.

The author says

that this volume is not offered as an exhaustive treatment of the subject, but is designed primarily for beginners. He feels that recent writers on iron metallurgy have addressed themselves too exclusively to those who are already well versed in its mysteries. As a student, he sought in vain for a simple and concise statement of the general principles; as a teacher, he longed for one to recommend to his students; in practical work he has had to admit to many ambitious workmen that there was nothing in the literature of the subject that came within their grasp. For more than a decade he has felt that there was need of such a treatment on lines essentially American, and now has attempted to supply it. He is well aware that there are many others better fitted to undertake the task. Their failure to do so is the best possible reason for his presumption.

And he has accomplished even more than he set out to do, for the book is not only the best elementary treatise on the modern American blast furnace, but contains a great deal of valuable data which will be useful to everyone but the few expert blast furnace men who stand at the top of their profession.

The volume begins with 22 introductory pages dealing with the physical properties of cast-iron and the effect of impurities upon it. These data are fairly good, and this is the only section which does not demand a more appreciative characterization. It is probable that if the author had had an opportunity to examine the proof sheets himself he would have changed many things in this section, because what sometimes appears to be due to lack of information on his part proves upon investigation to be a wrong impression conveyed by trying to condense too many data into a few words, or by stating half truth as if it were the whole truth. A single example will make this clear. On page 26, the author says:

Irons which are high in silicon are generally low in sulphur. This is probably largely due to the volatilization of the sulphur by the high temperature necessary to produce high silicon irons.

But it is very evident from what he says on pages 158, 220 and 222 that he is really aware how small a part of the elimination of sulphur is due to volatilization and how large a part devolves upon the slag.

The introduction is followed by a chapter on Materials of Manufacture, in which iron ores, the preparation of iron ores (roasting, agglomeration, and concentration), fuels, and fluxes are discussed in a very interesting and commercially valuable manner. The author does not say much about the world's supply of iron ore, but gives some interesting data on the history of the important United States deposits, and upon the conditions which determine the value of ore. The conditions governing the valuation of fuels and fluxes are also briefly touched upon.

In a book as skillfully and thoroughly prepared as this one, and dealing with a subject that has so long been neglected by authors during a period when it has advanced in practice more than at any other time in its history, it is difficult to pick out any particular chapter or section as being the best, but the reviewer is inclined to think that Chapter II., Description of Plant, will rank relatively very high in practical usefulness, because the information given therein is so complete and much of it was previously in the possession of only a comparatively few experts, and could not be found at all in literature, or at least only after long searching. This is especially true of the details of lining, tuyeres, dust catchers, cleaning apparatus (which latter, although available, was much scattered) and stoves.

Chapter III., Operation of the Furnace, is an excellent chapter for those for whom it is intended, namely, students and beginners, but does not pretend to exhaust the subject.

Burdening the Furnace, while good, is not treated as logically and clearly as the previous chapters. The reviewer confesses his inability to follow the slag calculation easily because of the very brief explanations of the different steps, but perhaps it would not be fair to blame this upon the author. The discussion of the constitution and functions of the slag is very good. The furnace control of manganese, phosphorus, and carbon is discussed, but, strange to say, the two most important impurities, silicon and sulphur, are treated only incidentally here, though further space is given to them in Chapter V.

Chapter V., Action Within the Furnace, is treated clearly and concisely and makes very profitable and easy reading. It includes the chemical reactions taking place between the ascending column of gases and the descending column of solids, a critical discussion of the heat development and heat efficiency of the furnace, limiting temperatures, volumes of blast and escaping gases, the effect of moisture and drying the blast, the effect of furnace dimensions, use of charcoal fuel, rapid driving, regularity and stock distribution.

Both Furnace Irregularities and Hints on Design of Equipment cannot fail to be of great interest and value to all students and beginners, and also to those who, however familiar they may be with practice in one locality, are desirous of keeping in touch with progress in the art elsewhere. The furnace irregularities include leaky tuyeres and coolers, burning out of the lining, pillaring, scaffolding, hanging, chilling of the hearth, etc. The design and construction of the furnace is critically discussed and the reasons for different details are carefully and judiciously stated. The design of stoves is especially valuable, because of the comparative rarity of these data and the thorough manner in which they are set forth. Blowing engines and boilers are analyzed, and last, but not least, gas engines, upon which, however, the data are not as full as they might be in view of the importance and the novelty of the subject.

Chapter VII. is followed by a supplement upon the uses and grades of pig iron, which briefly sets forth the chief facts in the manufacture of wrought iron and steel, and the composition of pig iron for gray, chilled and malleable castings. Other authorities may differ with Mr. Forsythe upon some of the statements made concerning the principles of these various operations, and perhaps if he had seen the work in proof he might himself have made a change in the wording here and there, where an impression is given which is perhaps not exactly that intended, but the data are accurate in the main and serve the purpose for which they were intended, namely, to inform the maker of pig iron upon the purposes of the different limitations placed upon it by the user.

The supplement is then followed by an appendix called Some Principles of Chemistry and Physics, which was written primarily for non-technical men and also to make more clear to those who studied these fundamental subjects some time ago the principles involved in the numerous thermal and chemical calculations which form so valuable a part of the volume. Here again the reviewer confesses a little difficulty in always grasping the writer's meaning on the first reading, but here likewise the fault may not be with the writer of the book.

Altogether this volume is a welcome and valuable addition to metallurgical literature, not only as a text-book but also as a small reference work, and it is greatly to be regretted that the untimely death of the author cut short his career before he had an opportunity to enlarge and extend it as his experience grew with the number of editions.

*Adjunct Professor, Department of Metallurgy, Columbia University, New York City.

THE FALLS OF NIAGARA.—Their Evolution and Varying Relations to the Great Lakes; Characteristics of the Power, and the Effects of Its Diversion. By Joseph William Winthrop Spencer, M. A., Ph. D., F. G. S. Ottawa, Can.: Department of Mines, Geological Survey Branch. Paper; 6½ × 9¾ ins.; pp. xxxi. + 490; 44 plates, 30 text illustrations, and one large folding map.

This study of the history, present conditions and future problems of Niagara Falls records many scientific data never before ascertained or presented. Careful and intelligent investigation, by means of soundings, borings and instrumental observations, painstaking examination of voluminous statistics and a sound mental correlation of the data thus ascertained, are amply evidenced in every chapter, yet the results are offered to the reader in such indiscriminate order of facts and poorly connected thought, that the effect upon his mind is that which a scientific field note-book would suggest. To one who has already thoroughly grasped the contents, the work must prove of the highest value, but the preliminary study necessitated by present arrangement of sentences, paragraphs and chapters is arduous.

The opening of the book is mainly devoted to the various surveys of the Niagara Falls district made since 1764, and points out past recession and changes of form, giving a probable prospect of slower recession in the future. Numerous facts of rock structure, glacial features and meteorological phenomena are given in Chapters VI. to XVII. The commercially important subject of lake fluctuation, of the lowering of the levels of Lakes Erie, Huron and Michigan now in progress owing to the electric-power generating requisition of the flow at the Falls, and of the limitations of such use, occupies the middle of the volume and, giving some new data and deductions, forms its immediately most useful part. The latter chapters are largely a resumé of the geologic condition of the region.

The text is illustrated with a fair number of maps, sketches and half-tones, the former of which labor under the same lack of proper juxtaposition of individual composition and as a series, which was above deplored in the book's general arrangement.

The author's work is a valuable addition to an important chapter of American scientific research, and, it is to be hoped, will in a future edition be put into more easily assimilable form.

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Airships Past and Present.

AIRSHIPS PAST AND PRESENT.—Together with Chapters on the Use of Balloons in Connection with Meteorology, Photography and the Carrier Pigeon. By [illegible] Hildebrandt, Captain and Instructor in the Prussian Balloon Corps. Translated by W. H. Story, 'New [illegible] D. Van Nostrand Co. Cloth; 5¾ × 9½ ins.; [illegible]; 222 illustrations, mostly in the text. $3.50, [illegible]

[illegible] interesting and instructive volume of [illegible]able size, the author has fully discussed [illegible] all subjects, at all closely related to aeronautics so far as they have been susceptible to popular treatment. He has disavowed all pretensions of writing a technical text-book, and has attempted rather an historical review of this science and art for the pleasure and profit of the general reader. To the translator belongs no little credit for the smoothness of the English diction.

The opening chapters review early attempts at artificial flight, even going back to mythical days and to legendary personages. The stories of the hot-air balloons of the Montgolfier brothers and of the hydrogen bags of Charles and Rozier are truly interesting. The theory of the balloon is explained quite simply, and it should be grasped by any reader who has a slight knowledge of physics or who has ever heard of Archimedes' famous expressions for buoyancy.

Four chapters form what seems to be a complete and detailed history of the dirigible balloon to date, following the chronological sequence of failures and successes grouped into three periods (1852 to 1872; 1883 to 1897; 1898 to 1906). The first period is marked by Giffard's attempts with comparatively large gas bags and very small horse-power of driving engines; the second is noted for the work of Renard and Krebs, who built the prototype of the most successful ones of the third period; the most spectacular work of this last period is conceded to lie in the indefatigable efforts of Santos Dumont.

The whole vast work on "heavier-than-air" flying machines is condensed into two chapters; one on self-propelling machines and one on kites. Brevity at this point may be attributed to two causes. Capt. Hildebrandt is an instructor in the Prussian Balloon Corps, and it is easily inferred that his duties have not brought him closely into touch with the "heavier-than-air" apparatus. Then, too, the design of such machines are so technical that they are not readily discussed, at any length, in a way at all illuminating to the general reader. However, all the notable machines are described and illustrated, which is perhaps sufficient. The remainder of the book, more than half of the volume, is devoted to pure ballooning; to the science, art and sport of drifting about in the upper air with such currents as therein may be found.

Much attention is paid to military ballooning, as is to be expected if one remembers the progress in aeronautics attained under military auspices. First, the adventures of Coutelle's balloon corps, in 1794, during the French campaign against the Austrians, are described and the development of this first military corps, with its resultant balloon school, is traced. The author has rather briefly shown the growth of the French and German systems of military aeronautics, and the more or less intimate relation the work in these two countries bears to that in all countries.

In a chapter on "Balloon Construction, Etc.," the chemistry of gas production is very simply set forth, and the methods of envelope construction are briefly outlined. For some reason, not quite apparent, this chapter includes a description of the kite balloon of Major Von Parseval and Capt. Von Sigsfeld. This is designed as a captive balloon of such steadiness that accurate observations could be made in it. Such steadiness is not a characteristic of the common form of balloon when held captive by ground ropes.

One of the most readable chapters of the book is that on ballooning as a sport. After telling about the formation of foreign balloon clubs and giving several records of speed, time and distance the author runs into reminiscent accounts of adventurous trips about Europe—from Berlin to the Carpathian back-woods and to Sweden, across the Alps and similarly about that part of the world.

"Scientific Ballooning" is the heading of a chapter which contains much detailed description of various ascents of balloons, with and without passengers, to secure meterological observations. The greater aims of scientific ballooning, the author explains, are to determine barometric changes with changes of light, to determine changes in the chemical constitution and in the electrical properties of the atmosphere at different altitudes, etc. The broad aim of scientific ballooning is well summed up in a quotation given from an address by Dr. Hergesell, Director of the Meteorological Institute in Alsace and Loraine:

> Our aim must be to explore the great unknown above our heads and to discover in it the secret of the weather chart.

Five chapters near the end of the book form a treatise on balloon photography. The first chapter is mainly historical, although there is also some discussion of the effect of balloon motions on the photographic image, on peculiarities of the atmospheric layers, and on precautions of various sorts necessary to secure good results. Another chapter deals with the construction of several successful and unsuccessful cameras, shutters, plate-holders, plates, films and other minor apparatus and appurtenances. A third chapter of this group describes the interpretation of photographs taken from such high situations as are very seldom attained except by balloons. This means showing how hills, valleys, roads, streams and forests may be picked out on these peculiar bird's-eye views, and how the photographs indicate the true nature of the country photographed.

The use of carrier-pigeons generally, and in connection with balloon-flights particularly, forms the subject material of one of the longer chapters of the book. Notes on breeding and training these birds are found in this part, along with photographic processes of preparing the messages. Interspersed through the chapter are stories of notable performances.

The final chapter of the book is one on the laws, military and civil, which may be expected for governing balloon flights. At present, of course, any one with means may be a balloonist without restriction, but Captain Hildebrandt holds that this is all to be changed, sooner or later.

While the book bears the date 1908, it appears to stop with 1906, and to omit some of the happenings of that year. This is only to be expected, since much time was lost between the preparation and printing of the German edition of Captain Hildebrandt's work and the appearance of the American translation.

LES MERVEILLES DE L'ELECTROCHIMIE.—Their Future in Peru. By Emile Guarini, Professor of Physics and Electricity in "l'Ecole Nationale des Arts et Métiers" at Lima, Peru. Paris, France: H. Dunod & E. Pinat. Paper; 6¼ × 9¾ ins.; pp. 152; plates and text illustrations. 5 francs; American price, $1.50.

The chief purpose of this descriptive summary of electrochemical and electrometallurgical achievements seems to be to stimulate the development and utilization of the water-powers of Peru. Only a brief two-page prefatory statement, however, refers directly to this matter of local application; here we find it stated that the available water-power of western Peru, i. e., excluding the remote eastern mountain section, is estimated by the author at 500,000,000 HP., and that this wonderful wealth could be put to good account in developing the equally marvelous mineral wealth of the country. The interesting theme is not again referred to. The text of the book is a dry recital of what has been done in building electric furnaces, in electrogalvanic work, in welding by electricity, in producing ozone and nitrogen compounds by spark discharges, etc. The style is unfortunately not strong enough to make interesting reading in the "popular" sense; on the other hand, the book is by far too sketchy and partial to have appreciable technical value.

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"Mr. Godfrey is original and often at variance with some of the accepted formulas used in designing reinforced-concrete structures. There is a strong view of common sense running through his treatise which will be appreciated by all interested in live questions of the day relating to reinforced concrete design and construction."—Cement and Engineering News, April, '08.

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Typhoid Fever: Its Causation, Transmission and Prevention

By George C. Whipple, AssociateMember of the American Society of Civil Engineers, Member Society of American Bacteriologists, etc. Introduction by William T. Sedgwick, Ph.D., Professor of Biology and Lecturer on Sanitary Science and the Public Health in the Massachusetts Institute of Technology, Boston. Large 12mo, xxxvi + 408 pages, 50 figures. Cloth, $3.00 net.

CONTENTS.—Introductory Essay: A Disease of Defective Civilization, by William T. Sedgwick. Typhoid Fever. Bacteriology of Typhoid Fever. The Typhoid Patient as a Focus of Infection. The Typhoid Bacillus at Large. Lines of Defense against the Typhoid Bacillus. Typhoid Fever Statistics. Distribution of Typhoid Fever. Typhoid Fever Epidemics. Investigation and Control of Typhoid Fever Epidemics. Influence of Public Water Supplies on the Typhoid Fever Death Rates of Cities. Effect of Milk Supplies on the Typhoid Fever Death Rates of Cities. The Financial Aspect.—Appendices: The Use of Disinfectants. House Flies. Estimation of Population. Corrected Death Rates. Bacteriological Description of the Typhoid Bacillus. Tests for the Diagnosis of Typhoid Fever. The Bacteriology of the Blood in Typhoid Fever: An Analysis of 1602 Cases. Examination of Water for the Typhoid Bacillus. Present Status of Water Analysis in Connection with the Investigation of Typhoid Epidemics. The Viability of the Typhoid Bacillus under Natural Conditions. Typhoid Fever in the United States Army Camps. Extracts from the Presidential Message of Theodore Roosevelt, December, 1907. Medicine in Peace and War. Data as to the Cost of Typhoid Fever. Typhoid Fever Literature. Typhoid Fever Statistics.

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Revolver and Pistol Tests.

REPORT OF BOARD ON TESTS OF REVOLVERS AND AUTOMATIC PISTOLS.—Appendix to Annual Report of the Chief of Ordnance, 1907. (William Crozier, Brigadier-General, Chief of Ordnance.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 116; nine plates.

Many men who never have used a revolver except at target practice, and who sincerely hope that that will be the extent of their gun play, are, nevertheless, intimately acquainted with the peculiarities and relative efficiencies of the various small arms. This military spirit, hereditary to most of the race, together with a sense of necessary preparation for possible self-defense, gives to the art and practice of pistol shooting a more than ordinary interest; so that all literature on the subject has a wider field of appreciation than its purely practical value would warrant. For this reason the report on pistols and revolvers, recently issued by the U. S. Chief of Ordnance, will be read by many others beside the army officers for whom it is more specifically intended, for, while the requirements of a revolver for the army are somewhat more rigid than for the civilian, it is safe to say that the arm most successfully passing the severe test of military service will satisfy the occasional user.

In March, 1907, a board of officers in the United States Army met to investigate the merits of various revolvers and pistols submitted for possible future adoption in the military service. There were brought before the board seven makes of automatic pistols, two double-action revolvers and one automatic revolver, all of 0.45-in. caliber, because the board had decided that an increase from the present 0.38-in. caliber was desirable. After a thorough study of the desired features in an army handarm and a most rigid series of mechanical tests it was decided that at present the automatic pistol had not been tested sufficiently in service to recommend its adoption for general use, but that in field tests certain makes had shown up so well that the army would be justified in equipping a number of troops with automatics in order that a thorough comparative service test could be made over an extended period. In accordance with this recommendation, the Secretary of War has ordered three troops of cavalry to be equipped with the Colt automatic 0.45 and three other troops with the Savage automatic 0.45, the various troop commanders to make careful records of the performance of each gun and report upon the same at the end of a year's service test under the same conditions of field duty, target practice, etc., now holding in the use of the regular service revolver. This year will be up about May, 1909.

The board also recommended that all the troops in the Philippines be armed with 0.45-in. caliber Colt double-action revolvers instead of the service 0.38's now in use, but the department disapproved this recommendation on the ground that there was no imminent prospect of warfare there, that the expenditure of $40,000 for the purchase of the new arms was at present inadvisable, and that any change of equipment should be withheld until the results of the service tests on the automatic pistols were known.

In the report there are included descriptions, both in text and in half-tone, of each of the pistols and revolvers submitted, the specified requirements of a perfect weapon, together with the items in which each sample either passed or failed, and a most complete account of the behavior of each gun under the prescribed tests.

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Electrical Railroading.

ELECTRICAL RAILROADING.—Or, Electricity as Applied to Railroad Transportation. By Sydney Aylmer-Small. Chicago, Ill.: Frederick J. Drake & Co. Leather; 4½ × 7 ins.; pp. 924; 539 illustrations, mostly in the text. $3.50.

Evidently this volume was prepared mainly for men who have had no knowledge of electricity previous to securing this particular book. The style, especially in the first part of the work, is catechetic: short sections on the various topics taken up, are followed by a series of questions and answers. The first third of the book deals with elementary electricity and magnetism, covering, in an inferior way, about the same ground as could be studied with any good text-book on elementary physics. The other two-thirds of the book seems to be largely copied from descriptive catalogs of prominent manufacturing companies, and from employee's instruction books, as issued by a few railroads. This two-thirds attempts to cover instruments, generators, switchboards, transmission systems, comparisons of steam and electric traction, methods of electric train control, electric locomotives and air brakes. The book contains a multitude of gross errors and loose or questionable statements. Such a number of these troubles as is found is all the more to be regretted in a book of this character, for the majority of its probable readers, not being familiar with the subject matter, cannot realize in advance the mistakes or know the proper statements that should have been made and hence are either led astray or greatly confused. In general, the illustrations are poor. The arrangement of subject matter is often without regard to logical sequence. For instance, a section on "Circuit Breakers" follows an elementary discussion of electrical work, power and efficiency and precedes a similar discussion on the characteristics of alternating-current circuits. A chapter on turn-tables is inserted between storage batteries and electrolysis. Right here it is interesting to quote an example of the loose statements prevalent:

> The word electrolysis means a loosening up by electricity done in a liquid. The pieces of the electrolyte produced by electrolysis are called ions.

In the section on "Systems of Control" (p. 605) the author speaks of all controllers as "K," "L," "M," etc., it is true that such letters are used to designate types of controllers used in common by the General Electric and Westinghouse companies, but these letters are only trade designations and are not universally used for controllers doing similar service. This is but one example of many failures to properly qualify statements taken from trade publications of manufacturing concerns.

The author presents a fairly good description of the New York Central motor cars and locomotives, of the New Haven single-phase locomotives and he has made brief mention of several types of electric locomotives in different classes of service. There are also good descriptions of the following systems of control: (1) rheostatic drum; (2) Sprague-General Electric, Type M, Direct Current; (3) single-phase alternating-current; (4) direct and alternating-current, Sprague-General Electric; (5) Westinghouse unit switch (electro-pneumatic).

Near the end of the book are "Instructions For The Operation of Multiple-Unit Control," which seem to be copies of the West Jersey & Seashore and New York Central Railroads' instructions to motormen. The author has failed to warn the reader that these apply specifically only to the equipment in these two cases.

There are so many errors that it would be impossible to mention them all. A few random instances will suffice to show the careless preparation of the volume.

> Surges may be produced by short circuits which are sudden (p. 85).
>
> * * * * * the surge may rise to four times the original pressure. So a 40,000-volt line might have one of its branch lines rise to 120,000 volts. (p. 88).
>
> Ohm's Law applies to A. C. when written thus
>
> $$C = \frac{\text{Impedence}}{\text{Volts.}} \quad \text{(p. 357).}$$
>
> Then a current is induced in the direction of the dead circuit in the same direction as current in the loaded circuit. (p. 368).

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> The A. C. then begins to run machine and C. power is delivered from the commutator A. C. (p. [illegible]).
>
> Fig. 174 shows the two legs of a transformer, which form its iron core, each over half filled with coils. The coil is made of sheets of soft iron. (p. [illegible]).
>
> The third rail is usually a 70-pound T [illegible] steel rail but lately rails with a certain percentage of copper in them are being used. The rail of the New York Central is copper alloyed. (p. 574).
>
> * * * Current is taken from the third rail system by eight collecting shoes, four on each side of the locomotive, arranged in pairs of two each. (p. [illegible]).

This list of blunders and gross misstatements could be prolonged almost indefinitely. One needs to stop right here, however, to note that the New York Central third rails certainly do not contain a single trace of copper. The carbon and manganese do have a fixed value and the maximum limit of sulphur and phosphorus are given, but the presence of copper is purely imaginary. It is pertinent to remark also that the center of the third rail is 2 ft. 4¼ ins. from the inside of the adjacent running rail; a distance equal to one-half the gage, instead of 2 ft. 5 ins. as shown on p. 577. Also the New York Central locomotives are rated at 2,200 HP. instead of 220, as noted on p. 809.

There is enough in the book that is new and useful to make it a matter for regret that so many criticisms need to be made. The book is safe for the instruction of motormen, etc., only under the direction of a well-educated engineer who will be able to recognize troubles which exist for the confusion of most readers.

ORGANIZATION, EQUIPMENT AND OPERATION OF THE STRUCTURAL-MATERIALS TESTING LABORATORIES AT ST. LOUIS, MO.—By Richard L. Humphrey. With Preface by Joseph A. Holmes, in Charge of Technologic Branch. Bulletin No. 329, U. S. Geological Survey, George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 84; 25 plates and 9 text illustrations.

To all engineers who intend to study or use the reports on testing materials issued by the U. S. Geological Survey, a careful inspection of this description of the laboratories is necessary. Never before has so lengthy and complete a series of tests been planned and the general scheme of procedure as well as the details of the mechanical equipment of the laboratories for such work are far in advance of any heretofore prepared.

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A Monograph on Lime and Lime-Mortar.

LUFTKALK UND LUFTKALKMOERTEL.—Results of Tests Made in the Royal Testing Institution at Gross-Lichterfelde West. By H. Burchartz. Berlin, Germany: Julius Springer. Paper; 7¾ × 11 ins.; pp. 184; 80 illustrations in the text. 9 marks; American price, $3.60.

Several standard works on building stone and mortar dismiss the subject of lime and lime-mortar with the brief statement that the use of lime in engineering construction is rapidly decreasing, and that the material need not be considered further. Eckel, in his "Cements, Limes and Plasters," is almost the only one to give specific consideration to the neglected material. In this state of affairs the ample collection of data now presented by Burchartz will be found of great value for reference. The author has drawn fully on the records of tests made at the Prussian government testing laboratory, with which he is connected, and in addition he gives the results of numerous special sets of tests planned to elucidate this or that question.

There are about one hundred pages devoted to lime and lime-mortar. The following main headings will suggest the scope of the discussion: Definition and Properties of Limes (air-limes, as the author calls them, in distinction from hydraulic limes); here also the volumetric yield in slaking and the influence of method of slaking on setting power are discussed, and a method given for making crushing tests of neat lime paste. Influence of Sand; size, cleanness and composition of sand are discussed, and the effect of adding finely-ground silicate sands, cement and other hydraulic additions is treated of. Effect of Sand Ratio. Influence of Density of Mortar. Effect of Method of Setting. All the principal points subject to discussion in this series of subjects are elucidated by the help of test data.

Some 75 pages are then devoted to the subject of strength of masonry (brickwork) laid up in lime-mortar. This is introduced by tables of tests of mortars showing the variation of strength of mortar testpieces with age, up to a year. Five sets of tests on brick masonry are recorded, one English and four continental; but there is no mention of modulus of elasticity of brickwork, a serious omission in view of the scarcity of data on this quantity. Finally, tests of adhesion and shear (or tangential adhesion) are recorded. There is a brief concluding section on the strength and water-resistant properties of mortar made with milk instead of water, which is not particularly favorable to the milk.

It is to be specially noted that practically all of this volume deals exclusively with fat or high-calcium lime, lean or magnesian limes being hardly more than mentioned. This restriction greatly unifies the treatment, as it confines the chemical questions to simple carbonation, except in so far as the formation of silicious compounds may be invoked in the questionable case of silicate materials in the sand. The carbonation, it is to be noted, is a very slow process, and in the interior of thick wall joints it does not occur at all, even in the course of centuries, as has been often demonstrated. Yet it is known that lime-mortar acquires an early strength just as cement has an initial set. The author shows that this early set is a purely mechanical or physical process, being a drying with a resultant compacting, exactly the same as the air-drying of clay from a soft or plastic state to a solid coherence. However, his tests show that good clays in air-drying develop a higher strength, both tensile and compressive, than this "initial" strength of lime-mortar. As to the process of carbonation itself, one of his least expected results is that water exerts a very strong favorable influence on the process, the presence of moisture being in fact essential. Tests in which mortar samples were periodically soaked in water showed much more rapid and thorough setting than in comparison specimens allowed to set in air.

The arrangement of the book is by no means ideal, with respect to easy and certain reference; but the large amount of raw material presented in the tables establishes its value.

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TELEPHONE CONSTRUCTION, INSTALLATION, WIRING, OPERATION AND MAINTENANCE.—By W. H. Radcliffe, E. E., and H. C. Cushing, Jr., E. E., Author of "Standard Wiring for Electric Light and Power." New York: The Norman W. Henley Publishing Co. Cloth; 4¼ × 7 ins.; pp. 171; 125 illustrations in the text. $1.

The authors of this small volume state that the book is intended as a working guide to standard telephone practice, and throughout the theoretical has been largely eliminated to give place for practical details. The old form of receiver is first described, and then all the classes of apparatus that have grown up about the old, simple telephone are described in turn. The assembling of the different parts of a modern telephone are shown by wiring diagrams for the series, bridging and intercommunicating systems. There is a chapter on line wiring, one on testing and one on switchboards. There are a few very notable errors, such as the interchange and inversion of cuts; however, the true arrangement is obvious in each case.

STATE WATER SUPPLY COMMISSION OF NEW YORK.—Annual Report for Year Ending Feb. 1, 1908, including Progress Report under Chapter 569 of the Laws of 1907. (Henry H. Persons, President of Commission.) Albany, N. Y.: Pub. Doc. Cloth; 5½ × 9 ins.; pp. 528; numerous folding and other plates and tables.

Besides the routine work of the Commission in passing on applications for the approval of plans for additional water supplies, this volume is composed chiefly of "Studies of Water Power Development under Chapter 569 of the Laws of 1907." These studies in turn are made up almost wholly of the detailed report by Mr. John R. Freeman, M. Am. Soc. C. E., on water storage and water-power projects on the Sacandaga and Genesee rivers. An abstract of Mr. Freeman's report appeared in our issue of April 30, 1908.

DIE PRUEFUNG UND DIE EIGENSCHAFTEN DER KALKSANDSTEINE.—Results of Tests Made in the Royal Testing Institution at Gross-Lichterfelde West. By H. Burchartz. Berlin, Germany: Julius Springer. Paper; 7¾ × 11 ins.; pp. 105; 13 illustrations, mostly in the text. 5 marks; American price, $2.

Sand-lime brick manufacture has nowhere reached such development as in Germany, where, since its reinvention (credited to Michaelis, 1880), a very large industry has grown up, using numerous different methods and (of course) different materials. The government testing laboratory at Gross-Lichterfelde has been frequently called upon to make tests of sand-lime brick, and thus has accumulated many records of strength and related data. These records and a very small amount of accompanying text form the present work. The various tests and the methods adopted in the governmental laboratory are described, and besides the full tabulated record of the results of routine tests, there are reports of a few special studies, including some tests of piers of sand-lime brick.

A suggestion as to reasonable specification requirements is given at the end of the text, substantially as follows:

The bricks must be of homogeneous texture. The water absorption should not exceed 15%. The crushing strength (brick tested dry) must be at least 2,100 lbs. per sq. in. for wall brick and 2,850 lbs. per sq. in. for paving brick. The stone must be unaffected by water, and the loss of strength due to absorption must not exceed 15%. The stone must be uninjured by freezing, and must show no loss of weight on 25 repetitions of freezing and thawing. The loss of compressive strength produced by this treatment must not exceed 20%. The original crushing strength to be determined as an average of ten tests. Variations of 10% below the specified strength are permissible.

The only remark on the fire-resisting properties of sand-lime brick which the book contains is the inadequate statement that such bricks resist fire and fire-and-water tests in substantially the same way as clay bricks.

Secondary Stresses in Bridge Trusses

By C. R. Grimm, C. E., Member of the American Society of Civil Engineers, Member of the American Association for the Advancement of Science, Member of the American Geographic Society. 8vo, viii + 140 pages, 60 illustrations, and 13 numerical examples. Cloth, $2.50.

CONTENTS.—General and Historical Notes. Nature of the Problem and Means for its Solution. Manderla's Method. Muller-Breslau's Method. Ritter's Method. Mohr's Method. Method of Least Work. Other Causes of Secondary Stresses than Riveted Joints in Main Trusses. Impact. Examples and Concluding Remarks. Literature.

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A Text-Book on Electrical Testing.

EXPERIMENTAL ELECTRICAL ENGINEERING.—And Manual for Electrical Testing. For Engineers and for Students in Engineering Laboratories. By V. Karapetoff. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. xxxiv. + 790; 538 illustrations in the text and 1 folding plate. $6.00 net.

Mr. Karapetoff's 800-page manual is a pretentious and formidable volume. Yet, outside of the author's own classes, any students who may be required to buy the volume will probably lose the feelings of awe, inspired by the size and price of the book, when they find that fully a quarter of the contents have already been made familiar by lecture and catalog. Obviously the work is a reprinted collection of lecture manuscript and mimeographed laboratory notes such as every technical school provides. There are chapters on resistance measurements, instruments, alternating-current circuits, magnetic circuits, photometry, power transmission, tests of direct and alternating-current machinery, electric batteries, switchboards, electric-railroad work, telephony, etc. The experiments range from simple fundamentals to the complicated applications of several principles, and are intended to cover the last two years of this work in a technical school. The author recommends three progressive courses, the experiments for which are to be picked here and there from this volume. It may be judged that Mr. Karapetoff was led to publish these notes because he was greatly dissatisfied with present texts on this subject and because he was well pleased with results of his own arrangement. However, that feeling is common to nearly all instructors in electrical engineering and there is some reason why teachers generally will not like this book, as a whole, any better than preceding similar ones.

There is a decided tendency in these notes to go into details of electrical practice—and shop practice at that. This seems decidedly against the trend of present engineering education by a reiteration of principles and a crowding of practice details to post-graduate study and experience. Then, too, the necessity of expounding concepts of inductance, self-induction, capacity, etc., of including very detailed descriptions of switchboards, switchboard apparatus, old types of arc lamps, etc., seems to reflect on the author's other lecture courses or on those of his co-workers.

Several tests, filling up valuable space, are seriously outlined, which do not illustrate basic principles of engineering and whose methods of procedure should be perfectly obvious to any student with a fair knowledge of theory. It seems too much to expect that a man should have been specifically instructed in school about the calibration of ground detectors, shop methods of winding coils, etc.

One section contains much descriptive matter on reflectors, shades and globes for incandescent lighting schemes, and here extracts from familiar trade publications are run in. All these common illumination aids have been given such extreme publicity in technical papers and in advertising that they do not form a desirable addition. This criticism also applies more or less to diagrams of railway and shop-motor controllers, which scarcely need repeating in such a manual.

There is an occasional looseness of thought and expression, accentuated, perhaps, by the general freedom from such troubles. For instance, the author, in speaking of voltaic cells, says:

> A battery consists of two electrodes of different substances immersed in a liquid (or a paste, as in dry batteries) * * * The following types of primary batteries are in most common use in this country: (1) Gravity cells; (2) Leclanché cell; (3) Edison cell; (4) Dry Batteries. * * *

There can be little excuse for thus encouraging in engineering students the careless habit of non-technical persons in calling a single voltaic cell a "battery." The next step beyond this is in encouraging students to imitate those who persist in speaking of a spark coil, a small dynamo or any other similar apparatus also as a "battery."

Several illustrations are drawn in such grotesque attempts at prospective that they can hardly be passed without specific criticism. No draftsman would ever show an unmistakably elliptical armature in an elliptical field frame, and it seems evident that the wax engraver had been allowed to fancifully work after rough sketches submitted to him.

Lack of attention to details in the make-up of the volume are damaging to the appearance and value of the book. The author can hardly be blamed for such troubles, but the publishers deserve some mild censure. In the first place, the relative values of the different parts of a chapter or a division are not exactly discernible. For instance, the chapter heading, in heavy capitals, is followed directly by a little text matter and then by an experiment number and title in heavy capitals and lower case letters as a side heading. An important division of chapter matter is marked by a center heading in light small capitals. This is certainly disconcerting. What follows the small capitals one takes at first to be a sort of overgrown foot note or supplementary explanation. In the second place, an arrangement of sub-captions, such as "object of experiment," "theory of method," "apparatus," "arrangement of data," etc., might have been inserted with great improvement. Moreover, such an arrangement in all chapters would have a marked effect on the quality of reports handed in, as regards their logical sequence and clean-cut appearance. Of course, the author has laid down the necessity and requirements for such kind of work in a preliminary chapter, but if the proper example is also set throughout the laboratory manual the quality of student's work is improved.

In spite of the many criticisms that can be made, this book has much in it of use, particularly for instructors. It will be of material assistance to them in arranging their own courses, even though they do not adopt it as a whole.

STATE ENGINEER AND SURVEYOR (NEW YORK).—Annual Report, for the Fiscal Year Ending Sept. 30, 1906. Albany, N. Y.: Pub. Doc. Cloth; 5½ × 9 ins.; pp. 555; folding and other plates. Supplement in separate volume (Report of Records and Gagings and Discharge of Streams in the State of New York): pp. 378; numerous tables and one folding sheet.

As is common in many State documents, the reports of the State Engineer and Surveyor of New York, for the fiscal year ending Sept. 30, 1906, is about a year and a half late. The report was transmitted to the Legislature on Jan. 15, 1907, but the delays incident to the publishing of public papers has held it from distribution until the present—so long a time that much of the current matter with which the report is filled has passed into uselessness. This is the last report of Mr. Henry A. Van Alstyne before he retired from the office of State Engineer, in January, 1907, and is mainly concerned with the two main duties of the office, the supervision of the canals and of the State highways.

As in all governmental reports there is much routine matter of only administrative interest, but there are also included several individual papers of value to the profession. Among these is the report of Mr. Arnold H. Chapman, giving the progress of experimental oiling of State highways during the year. The methods of applying the oil and the apparatus used are given, and, also, the detailed cost of applying the oil on eight different stretches of road ranging in length from 0.35 to 5 miles.

The monumenting of the New York-Pennsylvania State line is quite freely entered into, with detailed descriptions of many of the monuments. This information may be valuable to surveyors who are working in the neighborhood of this line. The last part of the main volume is a paper, "The Good Roads Question," read by Mr. Van Alstyne at Cornell University, on May 17, 1905, in which some valuable cost data are derived from the previous work of the department.

The supplementary volumes of the report consist of a report on stream gagings in the State during the year. The State Engineer's office, in connection with the U. S. Geological Survey, has had established about 90 stations on streams and lakes throughout the State, at which, during the years 1904-06, elevations have been taken and mean daily elevations computed. At some of these stations discharges have also been computed, but the greater majority have been only to establish water elevations.

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Profit Making in Shop and Factory.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.—By Charles U. Carpenter. New York: The Engineering Magazine. Cloth; 5¾ × 8¾ ins.; pp. 252. $2, net.

Of the many and various writings, good, bad and indifferent, on Factory Management, Mr. Carpenter's little book claims a high place for practical utility. The quality that marks it most strongly is vitality, or life-like character, or atmosphere of practice—whichever term may be preferred; the author succeeds in convincing the reader that he has been right in the midst of the conditions he talks about, and has experienced the chances both of success and of failure in the difficult problems of shop improvement. This is worth a great deal. No speculative theorizing, no mere desk product, can claim the same hearing that is accorded the record written from personal experience and observant study of practical results.

As the author interprets his subject, he gives it the broadest possible scope. Not only does he discuss the internal management, i. e., that which must secure maximum output, minimum cost, elimination of delays, and stability as well as progressiveness of manufacturing conditions, but he considers also the direction of the external phases of the business, such as marketing the product, keeping in touch with the demands of trade in order to bring out new products to meet changing demand and the like. But this second division of the subject occupies only a small part of the book, and its chief representation is a chapter headed The Upbuilding of a Selling Organization. In the main, therefore, the book is devoted to the internal management. This alone is so broad and complex a subject that it seems almost presumptuous to attempt covering it in one small book. In explanation it should be said that Mr. Carpenter's discussion is suggestive rather than systematic or exhaustive; it consists of hints as to what should be done and what should be avoided, what troubles may arise and how they may be forestalled.

Perhaps the leading recommendation of the author is for a thorough-going committee system, committees on various elements of the shop routine, made up of officials, superintendents, foremen and job-bosses, being required to hold regular meetings for discussion of routine progress and improvements. Almost as strong a point is made of efficient tool-room control, with the attendant features of supplying tools and work to all workmen in advance, keeping tools in proper working condition, and making it possible to apply the method of fixing standard times for the individual shop operation, the basis for a bonus or premium plan.

A very wise restriction of the book is the omission of all mention of "welfare" or "industrial betterment" work. Whatever may be said for or against such movements, it is clear at least that they are essentially not a part of the internal management of the shop or factory, any more than are questions such as proper types of roofing or lighting.

JOURNEYS OF OBSERVATION.—By T. A. Rickard, M. Am. Inst. M. E., Editor of the "Mining and Scientific Press," Author of "The Stamp-Milling of Gold Ores," etc. San Francisco: Dewey Publishing Co. Cloth; 6¼ × 9¾ ins.; pp. 255 + 130; numerous plates and text illustrations. $3.50; Author's Edition, $5.

At first, from the striking cover design and from the handsome illustrations, it might have been thought that this book was to prove such a one as an engineer would like to read on his vacation when he feels like putting aside inflexible computations and orderly arrays of data. From a superficial examination it might have been judged especially comforting to a tired city-dweller for it has, in its opening chapter, this passage:

As the city is left in our wake, growing dim amid its thin veil of smoke, the brutality of the crowds at Brooklyn Bridge, the foul air of the subway, the merciless sandbagging of Wall Street and the putrid politics of Tammany are forgotten in the beauty of the harbor and the splendor of its life.

Had the volume been saved to be read only between naps in the quiet country shade or where the swash of restless waves only emphasized one's own *dolce far niente*, the book might have been dropped with a tired sigh, for here is what is soon encountered:

In the mine the lateral displacement of the San Rafael lode is 130 ft. to the right. At the south shaft the cap is 284 ft. thick; near the north shaft it is 165 ft. higher (by reason of the rise in the ground in a length of 1,600 ft., which is the distance between the shafts) plus the fault (160 ft.), plus the elevation, making the present thickness 165 + 160 + 284 or 609 ft. South of the fault the lode is entirely in shale all the way down to the fifth level; just below that horizon there is andesite on the foot wall and shale on the hanging. . . . .

The new Esperanza ore body is a sight to gladden the eyes of a miner. It is 680 ft. long, with an average width of 9 ft. and an average yield of 75 grams of gold (or $49.70) per ton and 1,150 grams of silver ($19.55) per ton. . . . When first cut on the fifth level there were two veins close together; the first assayed $1.50 to $2 per ton, while the other, No. 2 to the west went $75 to the ton. Subsequent stoping gave a different story; the No. 2 has been payable only for 50 ft. above this level, while the No. 1 gets into rich ore 3 ft. above and only 15 ft. south of the crosscut. . . . . .

The sand is distributed by a revolving mechanism of the Butters & Mein type. There is no chemical treatment in the sand-receiver, the idea being to keep the mill water free from cyanide while effecting a final separation of slime so as to get a clean product. The sand when thus finally freed from the last trace of slime, is removed by a Blaisdell excavator, which drops it through a central opening onto a Robins belt-conveyor.

The volume starts off like a story of travels but soon shows that it is not merely an impressionistic diary of an aimless traveler in Mexico and Colorado. The reader is always seeing with the eyes of a mining geologist, and what is beheld are geological formations—Tertiary Sedimentaries, Middle Cretaceous limestones, lava tuffs, fully as much as the impressive massed beauties of high mountain and deep canyon.

The author, note-book and pencil in hand, takes his readers by boat from New York to Havana and to Vera Cruz. Thence he goes overland to Orizaba and Mexico City and from the latter place begin the geologist's pilgrimages to the more notable Mexican mining centers; El Oro, Pachuca, Guanajuato.

The trips from place to place are incidental linkages between collections of rather diversified (some people might say "scattered") notes on methods of tunneling, drifting, stoping and timbering, on processes of ore treatment and mine management. The paragraphs already quoted are typical of the manner of treatment, varying from broad description to terse records of data, though the extracts here given do not show the scope and judgment of the author's observation. There is a considerable massing of facts and figures which evidently have been put in from the author's extreme conscientiousness. Yet it hardly seems probable that this volume will be remembered as a reference work where can be found the exact dimensions of dams, the number of strands of wire in certain transmission cables or notes on the horsepower required to drive certain machinery. However, the case adjusts itself easily; the reader who does not care for such things in such a book as this can easily skip them for the parts giving him more pleasure at less mental effort.

There is a quite complete and deeply interesting description of one metallurgical process peculiarly Mexican, the *patio* amalgamation at the *haciendas de beneficio*. Here the poorer run of mine ores carrying less than two kilograms of silver are concentrated on vanners and canvas tables and the tailings go to the *patio* or court yard. The sludge in these open yards is allowed to thicken by evaporation, is treated to common salt, is mixed and aerated by the trampling of horses or mules, is given certain amounts of copper sulphate, again trampled and then sprinkled with finely divided mercury and the amalgam finally collected. But to realize how it is done and with what picturesqueness—read the book.

Thus far only the first part of the book has been mentioned—that on the Mexican travels. There is a smaller second part describing a trip across the San Juan mountains in southwestern Colorado and what of mining interest was seen about such famous mines as the "Revenue," "Camp Bird" and "Smuggler-Union," about Ouray, Telluride, Silverton and Gunnison. This part, as naturally would be expected, is more completely related to mining methods than the other part for the life and scenes in Colorado are less strange than in Mexico, and there is less of the picturesque; there are no dirty *peons* about; none of those large-hatted, closely-cloaked figures stalk across the scene at nightfall, like bandits of the comic opera.

Gillette & Hill

These well-known authors have just produced a 700-page book entitled "Concrete Construction, Methods and Cost," which no contractor, contractor's superintendent or engineer should be without. The book does not go into the theory of design, or into the testing of cements, but it is the most comprehensive treatise yet written on the economics of concrete and reinforced concrete construction—the methods and cost. Send for table of contents and sample pages. Its price is $5 net, postpaid.

The Myron C. Clark Pub. Co., 357 DEARBORN ST CHICAGO, ILL.

COMPARATIVE TESTS OF CARBON, METALLIZED CARBON AND TANTALUM FILAMENT LAMPS.—By T. H. Amrine. Bulletin No. 19, University of Illinois Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6 × 9 ins.; pp. 44; 32 illustrations in the text.

A long series of tests and studies is reported, in this bulletin, on the old familiar carbon filament electric lamp and on the newer "metallized" carbon and tantalum lamps. All the work described was carried out under such conditions that the results are directly comparable, and indicate the relative merits of the types studied. The studies of electrical and photometric characteristics are shown largely by curves and diagrams, and the results obtained are largely confirmatory of present data. One result, however, is a little at variance with present belief, and the portion of the bulletin treating this will be studied with interest by electrical engineers. In brief, it may be stated that lamps of all types when operated on a poorly regulated alternating-current circuit had a life 40 to 60% less than similar lamps on well-regulated, direct-current circuits free from mechanical shocks or vibrations. Readers will be disappointed that the relative detrimental effects of increased frequency, voltage variation, and mechanical disturbance were not studied and that the tungsten lamp was not commercially available at the time of the studies.

BULLETINS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 332: Report of the United States Fuel-Testing Plant at St. Louis, Mo., Jan. 1, 1906, to June 30, 1907. Joseph A. Holmes, In Charge. Pp. 299; numerous tables.

The results of investigations presented in this bulletin show a continuation of the general study of the fuel resources of the United States and are an addition to figures published in earlier reports of the Geological Survey, thus making available all data derived up to June 30, 1907. The work indicated is part of a plan to establish the real value of the various mineral fuel deposits and the most economical methods of utilization.

The introductions to each branch of the testing work, written by the officer in charge, showing equipment, personnel, methods and general results are collected at the front. The detailed tabulations of data are then given, and throughout the coals are classified by states. The results of the various classes of tests are given in sub-groups, covering chemical analyses, steaming tests, briquetting and producer gas tests, washing, coking and cupola tests.

TRAUTWINE'S CIVIL ENGINEERS' POCKET BOOK

18th Edition, 90th Thousand, 1907, $5.00

JOHN WILEY & SONS

SCIENTIFIC PUBLISHERS

43 and 45 East 19th Street, New York City

U. S. COAST AND GEODETIC SURVEY.—Report of the Superintendent, Showing the Progress of the Work from July 1, 1906, to June 30, 1907. (O. H. Tittmann, Supt.) Washington, D. C.: Pub. Doc. Cloth; 9 × 11½ ins.; pp. 595; folding and other plates through text and in pocket.

One of the minor troubles incident to such tremblings of the earth as shook up the western part of California on the morning of April 18, 1906, is the readjustment of all permanent marks for land measurement. Compared to the damage to life and property wrought by the earthquake this is of small importance, but to the surveyor who has established bases, bench marks and triangulation points, from which all of his past and future work is standardized, the unreliability of these marks incident to the earthquake is a real source of trouble. No part of the work of the U. S. Coast and Geodetic Survey during the past year is, therefore, of more importance, to a local field at least, than the investigation into the changes in triangulation points over the territory shifted by the 1906 earthquake, the records of which investigation form the first part of this year's annual report of the survey. The new surveys confirm the previous less rigid ones as to the general movement of the earth during the earthquake. It was found that points had moved parallel to the fault plane distances varying from almost zero to as much as 20 ft., taking opposite directions on opposite sides of the plane. So far as the changes in elevation go the report says there were none of sufficient magnitude to be detected with certainty. New points have been established from which to base future work.

In addition to this triangulation and the routine matters of the office, the report contains a series of measurements on six base lines with invar and with steel tapes, to test the relative accuracy of the two, a description of a long wire drag with which the high points in rivers and harbors may be located and, finally, the regular annual statement of the year's work in magnetic observations and current and tide surveys.

THE PLAN OF THE CITY OF COLUMBUS.—Report Made to the Hon. Charles A. Bond, Mayor, to the Honorable Board of Public Service and to the Honorable City Council, by Austin W. Lord, Albert Kelsey, Charles N. Lowrie, Charles Mulford Robinson and H. A. McNeil, Plan Commission. (Columbus, O.: The Commission.) Stiff paper; 9½ × 12½ ins.; pp. 56; folding and other plates, and text illustrations.

After a number of years of public agitation and some preliminary work by a Board of Trade committee, the city authorities of Columbus appointed a committee to report on improving the general street plan of the city, enlarging its park facilities and making suggestions for a civic center. Of the members of the Commission named in the title, Messrs. Lord and Kelsey are architects, of New York and Philadelphia, respectively, Mr. Lowrie is a landscape architect, of New York, Mr. McNeil a sculptor, of New York, while Mr. Robinson, of Rochester, N. Y., styles himself a civic adviser. The report discusses the three main subjects already mentioned, and is accompanied by a large number of handsome views, both local and foreign, to illustrate what nature has done and what man might do for Columbus, and what has been done in the way of city improvement by man elsewhere. There are also some diagrams, and finally a comprehensive map of the city and vicinity, showing proposed new streets and parks. One of the main features of the report is a suggestion for grouping public buildings in a systematic and esthetic way around the present State Capitol.

THE AMERICAN RAILWAY ASSOCIATION.—Proceedings, Apr. 22, 1903, to Oct. 24, 1906, inclusive. New York: The Association (W. F. Allen, Secretary, 24 Park Place). Cloth; 8 × 11¼ ins.; pp. xxix. + 737; folding plates and text illustrations. $5.

In accord with the object of this association, which is "the discussion and recommendation of methods for the management and operation of American railways," the work of its various committees is epitomized in the Proceedings for the past three years. Among the more important subjects discussed are Per Diem Rules, Tank-Car Specifications, A Standard Train-Rule Code and The Determination of Physical and Educational Qualifications of Employes.

Publications Received.

THE ANALYSIS AND GRADING OF CREOSOTES.—By Arthur L. Dean and Ernest Bateman, Experts. Circular 112, Forest Service, U. S. Department of Agriculture. Gifford Pinchot, Forester. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 44; 28 illustrations in the text.

ASSOCIATION OF ONTARIO LAND SURVEYORS.—Annual Report and Proceedings at the 15th Annual Meeting since Incorporation, Held at Toronto, Feb. 26-28, 1907. (Killaly Gamble, Secretary, Toronto, Canada.) Paper; 6 × 8¾ ins.; pp. 193; illustrated.

BOARD OF GAS AND ELECTRIC LIGHT COMMISSIONERS (Massachusetts).—Annual Report for the Calendar Year 1907, including Tables from the Annual Returns for the Year ending June 30, 1907. (Forrest E. Barker, Chairman.) Boston, Mass.: Pub. Doc. (No. 35). Paper; 5¾ × 9 ins.; pp. 263 + ccxvi.

BOARD OF HEALTH OF THE STATE OF NEW JERSEY.—Annual Report, 1907, and Annual Report of the Bureau of Vital Statistics. (Henry Mitchell, Secretary Board of Health.) Trenton, N. J.: Pub. Doc. Cloth; 5½ × 9 ins.; pp. 432; diagrams and tables.

BULLETINS, BUREAU OF THE CENSUS.—S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.

No. 92: Census of Manufacturers: 1905. Chemicals and Allied Products. Pp. 124.

No. 94: Statistics of Employees, Executive Civil Service of the United States, 1907. Pp. 164; nine diagrams.

BULLETINS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 333: Coal-Mine Accidents: Their Causes and Prevention. A Preliminary Statistical Report. By Clarence Hall and Walter O. Snelling. With Introduction by Joseph A. Holmes, In Charge of Technologic Branch. Pp. 21.

COMMISSIONER OF HIGHWAYS FOR THE STATE OF MAINE.—Annual Report for the Year 1907. (Paul D. Sargent, Commissioner.) Augusta, Me.: Pub. Doc. Cloth; 5½ × 9¼ ins.; pp. 124 + 102.

COMMITTEE ON ELECTROLYSIS, AMERICAN GAS INSTITUTE.—Conclusions of Committee and Reprints of Papers. By Albert F. Ganz, Professor of Electrical Engineering at the Stevens Institute of Technology, Consulting Electrical Engineer to the Committee. Stiff paper; 6 × 9 ins.; pp. 35; eight illustrations in the text.

CONCRETE CONSTRUCTION.—Methods and Cost. By Halbert P. Gillette, M. Am. Soc. C. E., M. Am. Inst. M. E., Managing Editor, Engineering-Contracting, and Charles S. Hill, C. E., Associate Editor, Engineering-Contracting. New York and Chicago: The Myron C. Clark Publishing Co. Cloth; 6 × 9¼ ins.; pp. 690; 306 illustrations in the text and 37 tables. $5, net.

EFFECT OF LOW TEMPERATURE ON BACTERIA IN ICE.—By John C. Sparks. (Reprinted from "Ice and Refrigeration" for April, 1908.) Paper; 9¼ × 13¾ ins.; pp. 3.

EMPLOYERS' LIABILITY IN UNITED STATES.—FOREIGN WORKMEN'S COMPENSATION ACTS.—Bulletin of the Bureau of Labor, No. 74, January, 1908. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 289.

FIRST COURSE IN CALCULUS.—By E. J. Townsend, Ph. D., Professor of Mathematics, University of Illinois, and G. A. Goodenough, M. E., Associate Professor of Mechanical Engineering, University of Illinois. New York: Henry Holt & Co. Cloth; 6 × 9½ ins.; pp. 466; 150 figures in the text. $2.50.

INTRODUCTION TO METALLOGRAPHY.—By Paul Goerens, Docent in Physical Metallurgy at the Royal Technical High School, Aachen. Translated by Fred. Ibbotson, A. R. C. Sc. I., Lecturer in Metallurgy, The University, Sheffield. London and New York: Longmans, Green & Co. Cloth; 5¾ × 9 ins.; pp. 214; 158 illustrations in the text. $2.50, net.

MACHINE DESIGN, CONSTRUCTION AND DRAWING.—A Text-Book for the Use of Young Engineers. By Henry J. Spooner, M. Inst. M. E., Assoc. M. Inst. C. E., Director and Professor of Mechanical and Civil Engineering in the Polytechnic School of Engineering, Regent St., London, Author of "The Elements of Geometrical Drawing," etc. London, New York and Bombay: Longmans, Green & Co., Cloth; 5½ × 8¾ ins.; pp. 691; 5 plates; 1,433 text illustrations and 86 tables. $3.50.

METHODS FOR EARTHWORK COMPUTATIONS.—By C. W. Crockett, Professor of Mathematics and Astronomy, Rensselaer Polytechnic Institute. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 114; 90 figures in the text. $1.50, net; English price, 6s. 6d., net.

NEW JERSEY SANITARY ASSOCIATION.—Proceedings of the 23d Annual Meeting, Held Oct. 1 and 2, 1907, in the Mariboro-Blenheim Hotel, Atlantic City, N. J. (James A. Exton, M. D., Secretary, Arlington, N. J.) Paper; 5¾ × 9 ins.; pp. 61.

NEW YORK CITY'S DEPARTMENT OF FINANCE.—Part I.: Report on Present Methods, with Suggestions for Reorganization. Submitted to the Hon. Herman A. Metz, Comptroller, by the Bureau of Municipal Research. (New York: Department of Finance.) Stiff paper; 7¾ × 10½ ins.; pp. 254; three folding charts.

THE OFFICIAL YEAR BOOK OF NEW SOUTH WALES, 1905-6.—H. C. L. Anderson, Director, Intelligence Department and Bureau of Statistics. Sydney, New South Wales: Pub. Doc. Boards; 6 × 10 ins.; pp. 817; numerous plates and one folding map.

POWER GAS PRODUCERS.—Their Design and Application. By Philip W. Robson, of the National Gas Engine Co., Ltd. London, England: Edward Arnold. Cloth; 5½ × 8¾ ins.; pp. 247; 105 illustrations, mostly in the text, and 31 tables. $3, net.

PROGRESS REPORTS OF EXPERIMENTS WITH DUST PREVENTIVES.—Circular No. 89, Office of Public Roads, U. S. Department of Agriculture. Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 26.

REFRIGERATION.—An Elementary Text [illegible]. By Wemyss Anderson, M. Inst. C. E., London and New York: Longmans. Cloth; 5½ × 8¾ ins.; pp. 242; 87 illustrations in the text. $2.25, net.

SCIENTIFIC AMERICAN INDEX OF [illegible]UFACTURERS.—New York: Munn & Co. Paper; [illegible] × 8 ins.; pp. 55. Sent free on request.

SECONDARY STRESSES IN BRIDGE[illegible]. By C. R. Grimm, M. Am. Soc. C. E. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 140; illustrations in the text and 15 tables. $2.50; Engl[illegible] 6d., net.

SIMPLE MINE ACCOUNTING.—By David [illegible]allace, Expert Mine Accountant. New York: [illegible] Publishing Co. Cloth; 6 × 9¼ ins.; pp. 63. $1.

STATE HIGHWAY CONSTRUCTION [illegible]. Second Report, for the Period from [illegible] Jan. 1, 1908. By Walter Wilson Cr[illegible] Chief Engineer (Division of Highways). Special Publication, Vol. VIII., Part I., Maryland Geological Survey; Wm. Bullock Clark, State Geologist. Baltimore, Md.: Pub. Doc. Paper; 7 × 10 ins.; pp. 95; eight plates.

STATIONARY ENGINEERING.—A Reference and Text Work Written Expressly for Stationary Engineers and Firemen; also Mechanical Engineers, Consulting Engineers, Electrical Engineers, Universities and Schools. By Joseph G. Branch, M. Am. Soc. M. E. Author "Heat and Light from Municipal and Other Waste," etc. In Three Volumes. Chicago and New York: Rand, McNally & Co. Cloth; 5¾ × 8 ins.; $2.50 per volume; $7 for complete set.

Vol I.: Steam Boilers and Attachments. Pp. 393; 126 illustrations in the text and 11 tables.

Vol. II.: Heating, Steam Engines, and Electricity. Pp. 373; 124 illustrations in the text and 10 tables.

Vol. III.: Elevators, Mechanical Refrigeration and Steam Turbines. Pp. 273; 70 illustrations in the text and 15 tables.

STEAM-ELECTRIC POWER PLANTS.—A Practical Treatise on the Design of Central Light and Power Stations and Their Economical Construction and Operation. By Frank Koester, Assoc. M. Am. Inst. E. E., Consulting and Designing Engineer. New York: D. Van Nostrand Co. Cloth; 7¼ × 10¾ ins.; pp. 455; folding and other plates, and numerous text illustrations. $5, net.

SUMMARY OF COMMONWEALTH STATISTICS OF TRANSPORT AND COMMUNICATION.—For the Years 1901 to 1906. Bulletin No. 1, Transport and Communication, Commonwealth Bureau of Census and Statistics. Published under the Authority of the Minister of Home Affairs, by G. H. Knibbs, Commonwealth Statistician. Melbourne, Australia: Pub. Doc. Paper; 8 × 13 ins.; pp. 26.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.—Bulletin No. 18, Corps of Engineers, U. S. War Department. To Supplement the Information Given upon the Charts of the Great Lakes, and Issued with those Charts. Detroit, Mich.: U. S. Lake Survey Office. Paper; 7¾ × 10 ins.; pp. 380; two folding tables.

THERMODYNAMICS OF TECHNICAL GAS-REACTIONS.—Seven Lectures. By Dr. F. Haber, O. Professor at the Technische Hochschule, Carlsruhe. Translated by Arthur B. Lamb, Director of the Havemeyer Chemical Laboratory, New York University, New York City. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ × 9 ins.; pp. 356; 20 illustrations in the text. $3, net.

TRANSPORTATION BY WATER: 1906.—United States Bulletin 91, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.; pp. 57; 8 diagrams and 65 tables.

A TREATISE ON THE PRINCIPLES AND PRACTICE OF HARBOR ENGINEERING.—By Bryssow Cunningham, Author of "Dock Engineering," etc. London, England: Charles Griffin & Co., Ltd. Philadelphia, Pa.: J. B. Lippincott Co. Cloth; 6¼ × 9¾ ins.; pp. 283; 248 illustrations, mostly in the text. $5, net.

TUNNEL UNDER STOREBELT OG BELTFORBINDELSERNE.—By Heinrich Ohrt. Copenhagen, Denmark: The Author (Vesterbrogade 116¹). Paper; 8¼ × 11 ins.; pp. 12; five illustrations in the text.

TYPHOID FEVER.—Its Causation, Transmission and Prevention. By George C. Whipple, Consulting Engineer. With an Introductory Essay by William T. Sedgwick, Professor of Biology, Massachusetts Institute of Technology. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¼ × 8 ins.; pp. xxxvi. + 407; folding plates and text illustrations. $3, net; English price, 12s. 6d., net.

THE USE OF THE SPLIT-LOG DRAG ON EARTH ROADS.—By D. Ward King. Farmers' Bulletin 321. U. S. Department of Agriculture (Logan Waller Page, Director). Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 14; five illustrations in the text.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 212: Surface Water Supply of the Great Basin Drainage, 1906. E. C. La Rue, Thomas Grieve, Jr., and Henry Thurtell, District Hydrographers. Pp. 98; two plates and two text figures.

No. 213: The Surface Water Supply of California, 1906. With a Section on Ground Water Levels in Southern California. (Great Basin and Pacific Ocean Drainages in California and Lower Colorado River Drainage.) W. B. Clapp, District Hydrographer, in cooperation with California State Board of Examiners. Pp. 219; four plates and two text figures.

No. 214: Surface Water Supply of the North Pacific Coast Drainage, 1906. J. C. Stevens, Robert Follansbee, and E. C. La Rue. Work in Oregon done in cooperation with the State Engineer. Pp. 208; three plates and two text figures.

No. 215: Geology and Water Resources of a Portion of the Missouri River Valley in Northeastern Nebraska. By G. E. Condra. Pp. 59; 11 plates (3 in pocket).

No. 217: Water Resources of Beaver Valley, Utah. By Willis T. Lee. Pp. 57; one plate, two text figures and numerous tables.